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## SECTION 20

# SPECIFICATIONS FOR CONSTRUCTION CONTRACTS

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**DISCUSSION**

**Chapter 2**  
**GUIDE CONSTRUCTION SPECIFICATIONS**

**Chapter 3**  
**GUIDE MATERIAL SPECIFICATIONS**

SOIL CONSERVATION SERVICE  
UNITED STATES DEPARTMENT OF AGRICULTURE

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NATIONAL ENGINEERING HANDBOOK

SECTION 20

SPECIFICATIONS FOR CONSTRUCTION CONTRACTS

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## NATIONAL ENGINEERING HANDBOOK

## SECTION 20

## SPECIFICATIONS FOR CONSTRUCTION CONTRACTS

## CHAPTER 1. DISCUSSION

GENERAL

The body of a construction contract consists of the general provisions, bid schedule, specifications, drawings and, when applicable, general conditions, special conditions and wage rate decisions. The general provisions are administrative and technical requirements that apply to all items of construction and to all contracts. In SCS practice these general provisions are furnished in preprinted form (Standard Form 23-A or Form SCS-43, as appropriate). The general conditions and special conditions are administrative instructions and requirements that apply to the specific contract and are prepared by the responsible administrative office. The bid schedule tabulates the items of work for which direct payment will be made, shows the estimated quantities of work and the units of measurement, and provides space for the entry of contract prices. The specifications and drawings include the technical details and requirements of the contract. The office responsible for the design of the works must concurrently develop the drawings and specifications and, in cooperation with the responsible administrative office, the bid schedule.

Instructions for preparing construction drawings are contained in Section 6 of this handbook and in current administrative memorandums. It is the purpose of this section to establish national guide specifications and procedures for preparing contract specifications and bid schedules.

TERMS AND DEFINITIONS

The following terms and definitions are established for use in all Service documents, publications and correspondence relating to specifications for construction contracts:

Construction specifications state the technical and workmanship requirements for the various operations required in the construction of the works, the methods of measurement and the bases of payments.

Material specifications state the quality of materials to be incorporated in the permanent works.

Guide specifications, containing optional clauses where options are permissible, are issued by the Engineering Division for use by the states and units as a basis for the compilation of standard construction specifications and standard material specifications.

Standard specifications are compiled by the states and units through selection of options from the guide specifications, for use in assembling contract specifications. They contain construction specifications and material specifications that are applicable to all construction work accomplished in the area and are usually preprinted and stocked at the appropriate design offices.

Interim standard specifications are specifications prepared by the states and units for use in assembling contract specifications that apply to construction items or materials that are not covered by national guide specifications.

Construction details are prepared by the design office and state the special requirements peculiar to a specific work of construction. They may take the form of written addenda to the standard construction specifications or of notes on the drawings.

Contract specifications are the complete specifications prepared for a specific contract and will normally consist of an assembly of appropriate standard specifications supplemented by lists and descriptions of items of work and by construction details.

#### APPLICABILITY

All specifications prepared by Service personnel, local sponsoring organizations or consultants for contracts financed wholly or partially by Flood Prevention (FP), Watershed Protection and Flood Prevention (566), or Resource Conservation and Development (RC&D) funds, except contracts for basic recreation facilities or fencing and seeding contracts that are not part of the prime contract, must conform to the format and intent of the guide specifications in order to: (1) insure adherence to laws and regulations; (2) prevent conflicts within the specifications and between the specifications and other contract requirements; (3) prevent omission of essential

elements; (4) prevent inclusion of extraneous materials; (5) provide a uniform basis for interpretation; and (6) insure uniform quality of Service project works. Deviation from this procedure will be allowed only when expressly approved by the Administrator.

### GUIDE SPECIFICATIONS

Guide specifications have been prepared for all construction operations and all construction materials normally required in Service projects. Guide construction specifications are contained in Chapter 2. Guide material specifications are contained in Chapter 3. The guide specifications will be modified by the Engineering Division whenever it appears appropriate to do so. Suggestions for changes, additions, deletions or corrections should be submitted to the Director of the Engineering Division.

#### GUIDE CONSTRUCTION SPECIFICATIONS

The guide construction specifications are written in the format prescribed for contract specifications. They contain optional clauses that may be selected by the specification writer, as needed, to adapt the standard specifications to regional or local needs. Each of the guide construction specifications is supplemented by instructions for its use. These instructions state the applicability of the specification and discuss the items of information that must be included in the contract specifications and drawings in order to completely define the specified item. They also discuss the conditions under which it may be appropriate to use any of the various options listed in the guide specifications. These supplementary instructions are included only for use by design personnel and will not be included in standard specifications compiled by use of the guide specifications.

#### GUIDE MATERIAL SPECIFICATIONS

Guide material specifications have been prepared for those materials whose quality must be uniform in all areas of applicability. They contain no optional clauses and are not supplemented by instructions for use. Items of information that must be included in the contract specifications in order to completely describe the materials required for a specific contract are listed in the instructions for use of the construction specifications to which the material specifications are complementary.

Reference to material specifications may be accomplished by statements in standard specifications or in construction details (either written or noted in the contract drawings).



## STANDARD SPECIFICATIONS

Standard construction specifications and standard material specifications should be compiled by all states engaged in continuing programs of construction. In order to attain the maximum possible uniformity in specifications, each Engineering and Watershed Planning Unit shall coordinate the compilation of standard specifications for use by the states within its area of responsibility.

### COMPILATION

A standard specification must conform verbatim to the parent guide specification except that in any clause for which the guide specification offers options only one of the options will be included in that clause of the standard specification. The options selected must be compatible with one another and with the conditions, materials and methods prevalent in the area of applicability and the requirements of the specified structural element.

The selection of more than one option in any clause of a specification is allowable only in the measurement and payment clauses of certain specifications that are identified in the instructions for use of the guide specifications. When two or more measurement and payment options are selected they shall be included in the standard specification as numbered methods (such as: "Method 1," "Method 2," etc.).

### NUMBERING

Each standard specification shall bear the same number as that of the guide specification from which it was prepared. When several different standard construction specifications for use in the same geographical area are prepared by selection of different combinations of options from the same guide specification, each specification shall bear the same number plus a distinctive letter designation (such as: 31A, 31B, etc.). The date of compilation shall be placed in the lower right-hand corner of each page.

### IDENTIFYING

The title of each standard specification shall be the same as that of the parent guide specification except that the word "(Guide)" shall be omitted. The word "standard" shall not be used in the title. The geographical area of application of each standard specification must be identified at the lower left-hand corner of each page of the specification. The identifying symbol should consist of "SCS" followed by the name of the state or area concerned, such as: "SCS-Idaho," "SCS-Corn Belt," "SCS-Northeast," "SCS-Conn., R.I.," etc.

### INTERIM STANDARD SPECIFICATIONS

States and units may prepare interim standard specifications for items not covered by guide specifications (such as methods or materials unique to a given locality) if there is a recurring need for such items in local contracts.

Interim standard construction specifications must:

1. Conform to the format of the guide specifications;
2. Be numbered consecutively starting with the number 200, and be dated and identified as prescribed for standard specifications;
3. Contain terms and definitions that are compatible with those used in the guide specifications;
4. Be concise and free from ambiguous clauses; and,
5. Contain measurement and payment clauses written in the same manner as those contained in the guide specifications.

Interim standard material specifications must:

1. Conform to the format of the guide specifications;
2. Be numbered consecutively starting with the number 300, and be dated and identified as prescribed for standard specifications;
3. Comply with laws and regulations regarding the mandatory use of Federal Specifications and Standards.

All interim standard specifications shall be submitted to the Director of the Engineering Division (via the responsible Engineering and Watershed Planning Unit) for approval prior to their use. When the specifications for a material covered by an existing Federal Specification or Standard contain requirements other than those included in the Federal Specification or Standard, the responsible Engineering and Watershed Planning Unit shall prepare a written justification for the deviation and submit two copies, along with two copies of the specification, to the Director of the Engineering Division.

Interim standard specifications submitted for approval will be considered for inclusion in the national guide specifications.

### BID SCHEDULE

The bid schedule forms the basis for payments to the contractor and must list all items of work for which direct payment will be made. Since the efficiency of contract administration may be directly affected by the manner in which the schedule is organized, the preparation of the bid schedule requires the close cooperation of the responsible designer and the responsible administrative officer. Operating procedures must include provision for administrative review of the bid schedule in the early stages of its development as well as on completion.

#### DESIGNATING THE ITEMS OF WORK

Considerable judgment based on design, construction and contracting experience is required to divide the work into items for inclusion in the bid schedule. On the one hand the schedule must be sufficiently comprehensive to allow the contractor to make reasonably accurate estimates of the cost of doing the work and to enable the contracting officer to keep orderly records of work progress and to accurately compute payments due; on the other hand, the number of scheduled items should be held to the minimum necessary to accomplish these purposes. The practicable extent to which the work should be divided into scheduled items must be judged in light of the quantities of work involved, customary local construction practices and other mitigating factors.

#### Division of the Work into Items

For maximum efficiency of contract administration the work should be divided into items on the basis of the following principles:

1. The work should be divided into items in a manner that will insure reasonable refinement of unit prices. The cost of any given type of work will vary according to its complexity and the complicating effects of the conditions under which it must be done. Generally, the scope of a bid item should be limited to a given type of work of a particular order of complexity. Exceptions to this rule may be justified on small jobs involving relatively small quantities of work.
2. The work should be divided into items in a manner that will prevent confusion of supplemental job requirements. Similar types of work may involve different sizes of components or different qualities of materials. To



prevent confusion, each variation of a given type of work should be established as a separate item of work. Also, the grouping of non-related items or similar components of separate works of improvement should be avoided (see Section 2603.3, Watershed Protection Handbook).

3. The work should be divided into items in a manner consistent with the cost sharing arrangements established in the watershed work plan and the project agreement. In many PL 566 projects, certain works of improvement may be paid for entirely or partially by the local sponsoring organization. To facilitate accounting of project costs, the work for such improvements should be established as separate items of work in the bid schedule, whenever practicable.

#### Numbering and Titling

Bid items must be numbered consecutively beginning with the number one. Sub-item numbers shall not be used. Each bid item shall be given a descriptive title that distinctly identifies the work to be done. All items that involve significant quantities of work (or significant procurement cost in the case of prefabricated units) should be designated as bid items.

#### PAY ITEMS

Measurable items whose quantities may be subject to variation should be designated for payment on a unit price basis and the estimated quantity of work and units of measurement must be shown in the schedule. Items that involve significant quantities of work but either are not conveniently measurable or whose quantities are not subject to variation should be designated for payment on a lump sum basis. An item involving a relatively insignificant quantity of work that is subject to only minor variation may be designated as a subsidiary item, compensation for which is included in the payment for another item. Subsidiary items will not be numbered nor listed in the bid schedule but must be designated and described in the contract specifications as prescribed in the instructions for preparing construction details.

Units of measurement must be compatible with the measurement and payment clauses of the specifications.

#### EXAMPLE 1-1

A typical bid schedule format is demonstrated by the following example:

Bid Schedule

<u>Item</u>	<u>Work</u>	<u>Spec. No.</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Amount</u>
1	Clearing, class A	1	12.5	ac.		
2	Excavation, common	21	300	cu.yd.		

CONTRACT SPECIFICATIONS

Contract specifications shall consist of an assembly of the appropriate standard (or interim standard) material specifications and construction specifications. Each construction specification will be supplemented by a section entitled: "Items of Work and Construction Details." The supplemental section of each construction specification shall: (1) be prepared especially for each invitation; (2) designate by number and title all of the bid items (exactly as numbered and titled in the bid schedule) to be performed in conformance with the requirements of the specification; (3) designate all subsidiary items to be performed in conformance with the requirements of the specification; (4) for each designated item of work, state such supplemental requirements and items of information as are needed to relate the standard specification to the job at hand; (5) bear the number that is next in sequence after the number of the last section of the standard specification; and, (6) be inserted into the contract specifications as the last page of the construction specification.

PREPARING CONSTRUCTION DETAILS

The construction details for each item of work should be concise and will normally contain (see instructions for use of construction specifications, Chapter 2):

1. Such definitions and descriptions as are needed to define the scope of the work;
2. The information required to define the types and qualities of materials to be used in the work;
3. Special requirements such as foundation preparation, grading tolerances, provisions for coordinating with other work, etc.; and
4. Other items of instruction necessary to define the construction requirements peculiar to the item of work.

The construction details should contain only such information and instructions as are needed to relate the standard construction specification to the job at hand. It is neither necessary nor desirable to emphasize or attempt to interpret provisions of the standard specification by repetition of the provisions in the construction details in the same or other words.

In preparing construction details, it must be recognized that notes on the drawings have the effect of specifications in defining the type and quality of materials to be furnished and in defining the scope of the work. Supplemental information or requirements that are directly related to details shown on the drawings may be stated in notes on the drawings rather than in the specifications if that arrangement will more conveniently and effectively convey the information to the personnel who will use it. The designer must use good judgment in deciding where the various supplemental data should be placed for maximum effectiveness. Usually, information shown by notes on the drawings need not be repeated in the specifications; however, if there is a compelling reason for doing so, great care must be taken to prevent conflicts between the notes and the specifications.

Construction details may not conflict with or interpret the general terms and conditions of the contract and may modify the standard specifications only to the extent that any clause that is associated with the phrase "unless otherwise specified" may be modified as needed.

#### Example 1-2

The following example demonstrates a typical supplemental section for excavation that would be written for a specific contract and inserted into the contract specifications as the last page of Construction Specification 21:

#### 11. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details therefor are:

##### a. Bid Item 7, Excavation, foundation, common

- (1) This item shall consist of the excavation of unsuitable materials from the foundation of the main dam in areas that are located within the base area of the dam but outside the limits of the cutoff trench.



- (2) The depth of excavation required is estimated to be about 5 feet at the central half of the base area of the dam and tapering to about 2 feet at the edges. The actual depths and extent of foundation excavation will be determined by the Engineer after his examination of the material encountered.
- (3) The sides of all foundation excavations shall be not steeper than 3 feet horizontal to 1 foot vertical.
- (4) Measurement and payment shall be by Method 1.

b. Bid Item 8, Excavation, cutoff trench, common

- (1) This item shall consist of all common excavation required within the limits of the cutoff trench as shown on the drawings.
- (2) The depth of excavation required is estimated to extend generally down to about Elevation 1105. The actual depths of excavation will be determined by the Engineer after his examination of the materials encountered.
- (3) Measurement and payment shall be by Method 1.

c. Bid Item 9, Excavation, cutoff trench, rock

- (1) This item shall consist of all rock excavation required within the limits of the cutoff trench as shown on the drawings.
- (2) Measurement and payment shall be by Method 1.

d. Bid Item 10, Excavation, principal spillway, common

- (1) This item shall consist of all common excavation required within the limits shown on the drawings for the installation of the pipe conduit, riser footing, and outlet structure, except for that portion of the excavation lying within the limits of the cutoff trench or above the lower limit of foundation excavation, and shall include all common excavation required for the installation of the anti-seep collars.



(2) Measurement and payment shall be by Method 1.

e. Bid Item 11, Excavation, principal spillway, rock

(1) This item shall consist of all rock excavation required within the limits shown on the drawings for the installation of the pipe conduit, riser footing, outlet structure and anti-seep collars, except for that portion of the excavation lying within the limits of the cutoff trench.

(2) Measurement and payment shall be by Method 2.

f. Bid Item 12, Excavation, emergency spillway, common

(1) This item shall consist of all common excavation required within the limits shown on the drawings for the construction of the emergency spillway.

(2) Measurement and payment shall be by Method 1.

g. Subsidiary Item, Excavation, borrow, common

(1) This item shall consist of all common excavation required for obtaining fill materials needed for construction of the permanent works.

(2) All borrow pits shall be graded to prevent the ponding of water in the pits.

(3) No separate payment will be made for borrow excavation. Compensation for borrow excavation will be included in the payment for earth fill, Bid Items 14 through 18, as appropriate.

#### SELECTING APPROPRIATE STANDARD SPECIFICATIONS

The type of work to be done or the type of structural detail required may often dictate the construction method or sequence. The specification requirements must be compatible with the methods that must be used. The specification writer must also make sure that the options selected in one specification are compatible with those selected in another. (For example, the method of designating pay limits for earth fill.)

PROCEDURE FOR ITEMS NOT COVERED BY STANDARD SPECIFICATIONS

Specifications for work not covered by standard specifications and that are intended for one-time use only in a specific contract shall be submitted to the responsible Engineering and Watershed Planning Unit for approval prior to their use. If such specifications are later considered for adoption as interim standard specifications, they shall be submitted for approval according to the procedures prescribed for review of interim standard specifications.

## CHAPTER 2

### GUIDE CONSTRUCTION SPECIFICATIONS



INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 1CLEARING1. Applicability.

Construction Specification 1 is applicable to the clearing of construction sites where grubbing is not required.

2. Material Specifications.

There are no material specifications complementary to Construction Specification 1.

3. Items to be Included in Contract Specifications and Drawings.

- a. When the areas to be cleared are definable on the site plan the limits of each class of clearing must be shown and clearly defined.
- b. When the areas to be cleared are not definable on the site plan (such as for many channel improvement jobs) the extent of each class of clearing required must be described by notes and designation of right-of-way boundaries and station limits.
- c. Areas in which disposal of refuse material will not be allowed or areas to which disposal will be restricted, if known.
- d. Required depth of cover over buried material, if applicable.
- e. Required surface grading over buried material, if applicable.
- f. Restrictions on blasting, if any.
- g. Special requirements for control of erosion, water pollution, and air pollution, if applicable.
- h. Methods of measurement and payment, if the standard specification includes more than one method.

4. Discussion of Options.

- a. Section 5, Disposal



- (1) Option 1 is intended for use when piling of material cannot be tolerated (such as within the limits of a flood retarding pool).
- (2) Option 2 is intended for use when the piling of material may be allowable (such as in the spoil bank area of a drainage channel).

b. Section 6, Measurement and Payment

- (1) Option 1 is intended for use when the areas to be cleared are extensive and can be defined in units of area on the ground and on the drawings. A reservoir area is a typical example of this type of site.
- (2) Option 2 is intended for use when the areas to be cleared cannot be defined in units of area but may be extensive. A channel right-of-way is a typical example of this type of site.
- (3) Both options may be included as numbered methods in standard specifications. In this case, the provision for lump sum payment may be designated as a third numbered method. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

All Methods. The following provisions apply to all methods of measurement and payment.

## CONSTRUCTION SPECIFICATION (GUIDE)

### 1. CLEARING

#### 1. SCOPE

The work shall consist of the clearing and disposal of trees, snags, logs, brush, shrubs, stumps and rubbish from the designated areas.

#### 2. CLASSIFICATION

Unless otherwise specified in Section 7, clearing will be classified according to the following definitions:

Class A clearing requires that trees and other woody vegetation be cut off flush with the ground surface.

Class B clearing requires that trees and other woody vegetation be so cut off that the remaining stumps extend no higher than 12 inches above the ground surface.

#### 3. MARKING

The limits of the areas to be cleared will be marked by means of stakes, flags, tree markings or other suitable methods. Trees to be left standing and uninjured will be designated by special markings placed on the trunks at a height of about six feet above the ground surface.

#### 4. CLEARING

All trees not marked for preservation and all snags, logs, brush, shrubs, and rubbish shall be cleared from within the limits of the marked areas.

#### 5. DISPOSAL

(Option 1) All materials cleared from the designated areas shall be burned or buried at locations approved by the Engineer, or otherwise disposed of as approved by the Engineer.

(Option 2) All materials cleared from the designated areas shall be burned, buried or piled at locations approved by the Engineer, or otherwise disposed of as approved by the Engineer.

(1-1)



6. MEASUREMENT AND PAYMENT

(Option 1) For items of work for which specific unit prices are established in the contract, the cleared areas will be measured to the nearest 0.1 acre. Payment for clearing will be made at the contract unit price for the designated class and shall constitute full compensation for all labor, equipment, tools and all other items necessary and incidental to the completion of the work.

(Option 2) For items of work for which specific unit prices are established in the contract, each tree, stump and snag having a diameter of 4 inches or greater and each log having a diameter of 4 inches or greater and a length of 10 feet or greater will be measured prior to removal. The size of each tree and snag will be determined by measuring its trunk at breast height above the natural ground surface. The size of each log will be determined by measuring the butt and by measuring its length from butt to tip. The size of each stump will be measured at the top. Diameter shall be determined by dividing the measured circumference by 3.14.

Payment for clearing and disposal of each tree, stump and snag having a diameter of 4 inches or greater and each log having a diameter of 4 inches or greater and a length of 10 feet or greater will be made at the contract unit price for its size designation as determined by the following schedule:

<u>Measured Diameter</u>	<u>Size Designation</u>
4 inches to 8 inches	6-inch size
Over 8 inches to 12 inches	10-inch size
Over 12 inches to 24 inches	18-inch size
Over 24 inches to 36 inches	30-inch size
Over 36 inches to 60 inches	48-inch size
Over 60 inches	60-inch size

The sum of such payments shall constitute full compensation for all labor, equipment, tools and all other items necessary and incidental to the work of completely clearing the designated areas, including clearing and disposal of smaller trees, stumps, snags and logs and brush, shrubs and rubbish.

(Use with Either Option) For items of work for which specific lump sum prices are established in the contract, payment for clearing will be made at the contract lump sum prices. Such payment shall constitute full compensation for all labor, equipment, tools and all other items necessary and incidental to completion of the work.

(1-2)

NEH 6/1/68 (Notice 20-23)

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

(1-3)

NEH 6/1/68 (Notice 20-23)



INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 2CLEARING AND GRUBBING1. Applicability.

Construction Specification 2 is applicable to the clearing and grubbing of construction sites.

2. Material Specifications.

There are no material specifications complementary to Construction Specification 2.

3. Items to be Included in Contract Specifications and Drawings.

- a. When the areas to be cleared and grubbed are definable on the site plan, their limits must be shown and clearly defined.
- b. When the areas to be cleared are not definable on the site plan (such as for many channel improvement jobs), the extent of clearing and grubbing required must be described by notes and/or designation of right-of-way boundaries and station limits.
- c. Areas in which disposal of refuse material will not be allowed or areas to which disposal will be restricted should be shown if such restrictions are necessary.
- d. Special requirements for depth of grubbing when appropriate.
- e. Required depth of cover over buried material, if applicable.
- f. Required surface grading over buried material, if applicable.
- g. Restrictions on blasting, if any.
- h. Special requirements for control of erosion, water pollution, and air pollution, if applicable.
- i. Methods of measurement and payment, if the standard specification includes more than one method.



4. Discussion of Options.

Section 5, Measurement and Payment

- (1) Option 1 is intended for use when the areas to be cleared and grubbed are extensive and can be defined in units of area on the ground and on the drawings. A reservoir area is a typical example of this type of site.
- (2) Option 2 is intended for use when the areas to be cleared and grubbed cannot be defined in units of area but may be extensive. A channel right-of-way where the kind of clearing varies in different reaches is a typical example of this type of site.
- (3) Both options may be included as numbered methods in standard specifications. In this case, the provision for lump sum payment may be designated as a third numbered method. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

All Methods. The following provisions apply to all methods of measurement and payment.

CONSTRUCTION SPECIFICATION (GUIDE)2. CLEARING AND GRUBBING1. SCOPE

The work shall consist of the clearing and grubbing of designated areas by removal and disposal of trees, snags, logs, stumps, shrubs and rubbish.

2. MARKING

The limits of the areas to be cleared and grubbed will be marked by means of stakes, flags, tree markings or other suitable methods. Trees to be left standing and uninjured will be designated by special markings placed on the trunks at a height of about six feet above the ground surface.

3. REMOVAL

All trees not marked for preservation and all snags, logs, brush, stumps, shrubs and rubbish shall be removed from within the limits of the marked areas. Unless otherwise specified, all stumps, roots and root clusters having a diameter of one inch or larger shall be grubbed out to a depth of at least two feet below subgrade elevation for concrete structures and one foot below the ground surface at embankment sites and other designated areas.

4. DISPOSAL

All materials removed from the cleared and grubbed areas shall be burned or buried at locations approved by the Engineer, or otherwise disposed of as approved by the Engineer.

5. MEASUREMENT AND PAYMENT

(Option 1) For items of work for which specific unit prices are established in the contract, the cleared and grubbed areas will be measured to the nearest 0.1 acre. Payment for clearing and grubbing will be made at the contract unit price and shall constitute full compensation for all labor, equipment, tools and all other items necessary and incidental to the completion of the work.

(2-1)

(Option 2) For items of work for which specific unit prices are established in the contract, each tree, stump and snag having a diameter of 4 inches or greater and each log having a diameter of 4 inches or greater and a length of 10 feet or greater will be measured prior to removal. The size of each tree and snag will be determined by measuring its trunk at breast height above the natural ground surface. The size of each log will be determined by measuring the butt and by measuring its length from butt to tip. The size of each stump will be measured at the top. Diameter shall be determined by dividing the measured circumference by 3.14.

Payment for clearing and disposal of each tree, stump and snag having a diameter of 4 inches or greater and each log having a diameter of 4 inches or greater and a length of 10 feet or greater will be made at the contract unit price for its size designation as determined by the following schedule:

<u>Measured Diameter</u>	<u>Size Designation</u>
4 inches to 8 inches	6-inch size
Over 8 inches to 12 inches	10-inch size
Over 12 inches to 24 inches	18-inch size
Over 24 inches to 36 inches	30-inch size
Over 36 inches to 60 inches	48-inch size
Over 60 inches	60-inch size

The sum of such payments shall constitute full compensation for all labor, equipment, tools and all other items necessary and incidental to the work of completely clearing and grubbing the designated areas, including clearing, grubbing and disposal of smaller trees, stumps, snags and logs and brush, shrubs, roots and rubbish.

(Use with Either Option) For items of work for which specific lump sum prices are established in the contract, payment for clearing and grubbing will be made at the contract lump sum price. Such payment shall constitute full compensation for all labor, equipment, tools and all other items necessary and incidental to completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 6 of this specification.

(2-2)

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 3STRUCTURE REMOVAL1. Applicability.

Construction Specification 3 is applicable to the removal of all types of structures, including fencing, from construction sites.

2. Material Specifications.

There are no material specifications complementary to Construction Specification 3.

3. Items to be Included in Contract Specifications and Drawings.

- a. The location and type of each structure or fence to be removed or the limits of the area from within which structures are to be removed must be shown on the plan and profiles of the site. If structure removal is designated by area limits, the location and type of all buried structures to be removed must be shown in addition to the area limits. All known information regarding the structures must be shown on the drawings.
- b. The location and types of structures or fences to be preserved in place or to be salvaged must be shown on the plan and profiles of the site.
- c. The required extent and depth of removal.
- d. The locations of storage areas for salvaged structural materials must be shown on the plan or indicated by appropriate notations.
- e. Areas in which disposal of refuse material will not be allowed or areas to which disposal will be restricted, if known. If refuse materials must be disposed of off the right-of-way, make appropriate notations.
- f. Structures, including fences, to be removed by others.
- g. Required depth of cover over buried material, if applicable.

- h. Required surface grading over buried material, if applicable.
- i. Restrictions on blasting, if any.
- j. Special requirements for control of erosion, water pollution, and air pollution, if applicable.
- k. Note that a separate bid item for salvage may be needed because of cost sharing arrangements. (See Chapter 1.)

4. Discussions of Options.

a. Section 2, Marking

- (1) Option 1 is intended for use when the structures to be removed are of significant size or when several widely separated structures must be removed. Whenever possible this option should be used in preference to Option 2.
- (2) Option 2 may be used when many small structures, such as irrigation turnouts, check structures and lined ditches, are located within the limits of construction site.

b. Section 3, Removal

- (1) Option 1 is compatible with Option 1, Marking, and must be used in specifications where Option 1, Marking, is selected.
- (2) Option 2 is compatible with Option 2, Marking, and must be used in specifications where Option 2, Marking, is selected.

c. Section 6, Measurement and Payment

The first two paragraphs may be designated as numbered methods in standard specifications. If number methods are used, insert the following paragraph before the next to the last paragraph in the section:

Both Methods. The following provisions apply to both methods of measurement and payment.

CONSTRUCTION SPECIFICATION (GUIDE)3. STRUCTURE REMOVAL1. SCOPE

The work shall consist of the removal, salvage and disposal of structures (including fences) from the designated areas.

2. MARKING

(Option 1) Each structure unit to be removed will be marked by means of stakes, flags, painted markers or other suitable methods.

(Option 2) The limits of the areas from which structures must be removed will be marked by means of stakes, flags or other suitable methods. Structures to be preserved in place or salvaged will be designated by special markings.

3. REMOVAL

(Option 1) All structures designated in the contract for removal shall be removed to the specified extent and depth.

(Option 2) Within the areas so marked all visible structures and attachments and all buried structures located and identified by survey stakes shall be removed to the specified extent and depth.

4. SALVAGE

Structures that are designated to be salvaged shall be carefully removed and neatly placed in the specified storage areas. Salvaged structures that are capable of being disassembled shall be dismantled into individual members or sections. Such structures shall be neatly matchmarked with paint prior to disassembly. All pins, nuts, bolts, washers, plates and other loose parts shall be marked or tagged to indicate their proper locations in the structure and shall be fastened to the appropriate structural member or packed in suitable containers. Materials from fences designated to be salvaged shall be placed outside the work area on the property from which they were removed. Wire shall be rolled into uniform rolls of convenient size. Posts and rails shall be neatly piled.

(3-1)



5. DISPOSAL OF REFUSE MATERIALS

Refuse materials resulting from structure removal shall be burned or buried at locations approved by the Engineer or otherwise disposed of as specified or as approved by the Engineer.

6. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, payment for the removal of each structure unit, except fences, will be made at the contract unit price. Fences removed or removed and salvaged will be measured to the nearest linear foot. Payment for fence removal or removal and salvage will be made at the contract unit prices appropriate to each type and size of fence.

For items of work for which specific lump sum prices are established in the contract, payment for structure removal will be made at the contract lump sum price.

Such payment will constitute full compensation for all labor, equipment, tools, and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.



INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 8MOBILIZATION1. Applicability

Construction Specification 8 is applicable to any construction contract that contains a bid item for general mobilization of the Contractor's personnel and equipment. It is not intended to cover mobilization of special equipment for specific items of work, such as grouting equipment, for which payment for mobilization is provided elsewhere in the contract.

2. Material Specifications

There are no material specifications complementary to Construction Specification 8.

3. Items to be Included in Contract Specifications and Drawings

- a. Special requirements pertaining to mobilization, if any.
- b. Any particular work for which payment will or will not be made under the mobilization item if not adequately described by the specification.

4. Discussion of Options

No options are included.



CONSTRUCTION SPECIFICATION (GUIDE)8. MOBILIZATION1. SCOPE

The work shall consist of the mobilization of the Contractor's forces and equipment necessary for performing the work required under the contract.

It shall include the purchase of contract bonds; transportation of personnel, equipment, and operating supplies to the site; establishment of offices, buildings, and other necessary facilities at the site; and other preparatory work at the site.

It shall not include mobilization for any specific item of work for which payment for mobilization is provided elsewhere in the contract.

The specification covers mobilization for work required by the contract at the time of award. If additional mobilization costs are incurred during performance of the contract as a result of changed or added items of work for which the contractor is entitled to an adjustment in contract price, compensation for such costs will be included in the price adjustment for the items of work changed or added.

2. PAYMENT

Payment will be made as the work proceeds, after presentation of invoices by the Contractor showing his own mobilization costs and evidence of the charges of suppliers, subcontractors, and others for mobilization work performed by them. If the total of such payments is less than the contract lump sum for mobilization, the unpaid balance will be included in the final contract payment. Total payment will be the lump sum contract price for mobilization, regardless of actual cost to the Contractor.

Payment will not be made under this item for the purchase costs of materials having a residual value, the purchase costs of materials to be incorporated in the project, or the purchase costs of operating supplies.

Payment of the lump sum contract price for mobilization will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to completion of the work.





INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 10WATER FOR CONSTRUCTION1. Applicability.

Construction Specification 10 is applicable to all water used at the construction site. It is to be used when a pay item for water is provided in the contract. A pay item for water should be provided when the cost of water is expected to be a significant part of the total cost of the items of work in which it is to be used.

If the water is to be furnished free to the Contractor at some designated source, the pay item should cover the remaining costs of transporting it and using it as specified. More than one pay item may be used if the cost of water is expected to be different for various purposes.

2. Material Specifications.

There are no material specifications complementary to Construction Specification 10.

3. Items to be Included in Contract Specifications Bid Schedule and Special Provisions.

- a. Pay item for water and estimated quantity--in the Bid Schedule.
- b. Unit price to be paid for water--in the Bid Schedule. (A fair price is to be predetermined based on the engineer's estimate of the cost.)
- c. Contract amount for water; i.e., the estimated quantity times the unit price--in the "Amount" column of the Bid Schedule.
- d. A statement in the Special Provisions that (1) the quantity variations clause of the General Provisions or the Special Provisions (depending on where the quantity variations clause is located in the particular contract) shall not apply to the water item, (2) there is no guarantee as to the quantity of water that will be needed, and (3) payment will be made at the contract unit price regardless of the amount used.
- e. Designated source of water, and details of ownership and water rights, if applicable--in the Special Provisions.

- f. Cost to the Contractor of water at the designated source, if applicable--in the Special Provisions. (It may be advantageous to contract separately with the owner of the water and furnish it to the Contractor free at the source. This should be done only if the net cost to the Service would be less.)
  - g. Special requirements pertaining to furnishing and using water, including water quality requirements if quality may be a problem.
  - h. Details of what water will be included in the pay item if exceptions are to be made to the provisions of Section 6.
4. Discussion of Options.
- No options are included.

CONSTRUCTION SPECIFICATION (GUIDE)10. WATER FOR CONSTRUCTION1. SCOPE

The work shall consist of furnishing, transporting, and using water for construction purposes in accord with the applicable specifications.

2. FACILITIES AND EQUIPMENT

The Contractor shall build and maintain such access and haul roads as are needed, and shall furnish, operate, and maintain all pumps, piping, tanks, and other facilities needed to load, transport, and use the water as specified.

These facilities shall be equipped with meters, tanks, or other devices by which the volume of water supplied can be measured.

3. DUST ABATEMENT AND HAUL ROAD MAINTENANCE

Water for dust abatement and haul road maintenance shall be applied to haul roads and other dust-producing areas as needed to prevent excessive dust and to maintain the roads in good condition for efficient operation while they are in use.

4. EARTH FILL, DRAIN FILL, ROCK FILL

Water for earth fill, drain fill, or rock fill shall be used in the fill materials as specified in the applicable construction specifications.

5. CONCRETE, MORTAR, GROUT

Water used in mixing or curing concrete, pneumatically applied mortar, or other portland cement mortar or grout shall meet the requirements of the applicable construction specifications and shall be used in conformance with those specifications.

6. MEASUREMENT AND PAYMENT

For water items for which specific unit prices are established in the contract, the volume of water furnished and used in accordance with the specifications will be measured to the nearest 1000 gallons.

(10-1)

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Except as otherwise specified, the measurement for payment will include all water needed at the construction site to perform the work required under the contract in accordance with the specifications but will not include water wasted or used in excess of the amount needed. It will not include water used in concrete which is mixed elsewhere and transported to the site.

Payment for water will be made at the contract unit price which shall be the price per 1000 gallons shown in the Bid Schedule. Such payment will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to furnishing, transporting, and using the water.



INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 11  
REMOVAL OF WATER

1. Applicability.

Construction Specification 11 is applicable to the temporary diversion of surface water and dewatering of the construction site and borrow areas during the construction period.

2. Material Specifications.

There are no material specifications complementary to Construction Specification 11.

3. Items to be Included in Contract Specifications and Drawings.

- a. Special requirements or restrictions applicable to the diversion works or to the method of diverting surface water.
- b. Special requirements for dewatering the construction site (such as a requirement that the water table be lowered before excavation is begun, or that it be maintained at a certain level below the bottom of the excavation during construction operations).
- c. Special requirements for dewatering borrow areas (such as removal of surface water and subsurface drainage to keep the borrow material at a workable moisture content during borrowing operations. A bid item for dewatering borrow areas should be used if it is expected to require a substantial amount of work.)
- d. Information regarding alternate borrow areas that may be used in lieu of dewatering the primary borrow area if applicable.
- e. Special requirements for control of erosion and water pollution if applicable.
- f. Waiver of the requirement that the Contractor furnish his plan for diverting surface water or dewatering the construction site, if his plan in writing is not wanted.
- g. Items of work may be separated in whatever manner is deemed most expedient for the particular contract. Usually, diverting surface water and dewatering should be established as

separate bid items. Dewatering can be broken down into several items (such as, "Dewatering, Core-Trench," or "Dewatering, Borrow Area 6") if better administrative control will likely result.

4. Discussion of Options.

No options are included.

CONSTRUCTION SPECIFICATION (GUIDE)11. REMOVAL OF WATER1. SCOPE

The work shall consist of the removal of surface water and ground water as needed to perform the required construction in accordance with the specifications. It shall include (1) building and maintaining all necessary temporary impounding works, channels, and diversions, (2) furnishing, installing and operating all necessary pumps, piping and other facilities and equipment, and (3) removing all such temporary works and equipment after they have served their purposes.

2. DIVERTING SURFACE WATER

The Contractor shall build, maintain, and operate all cofferdams, channels, flumes, sumps, and other temporary diversion and protective works needed to divert streamflow and other surface water through or around the construction site and away from the construction work while construction is in progress. Unless otherwise specified, a diversion must discharge into the same natural drainageway in which its headworks are located.

Unless otherwise specified, the Contractor shall furnish to the Engineer, in writing, his plan for diverting surface water before beginning the construction work for which the diversion is required. Acceptance of this plan will not relieve the Contractor of responsibility for completing the work as specified.

3. DEWATERING THE CONSTRUCTION SITE

Foundations, cutoff trenches and other parts of the construction site shall be dewatered and kept free of standing water or excessively muddy conditions as needed for proper execution of the construction work. The Contractor shall furnish, install, operate and maintain all drains, sumps, pumps, and other equipment needed to perform the dewatering as specified. Dewatering methods that cause a loss of fines from foundation areas will not be permitted.

Unless otherwise specified, the Contractor shall furnish to the Engineer, in writing, his plan for dewatering before beginning the construction work for which the dewatering is required. Acceptance of this plan will not relieve the Contractor of responsibility for completing the work as specified.

(11-1)

4. DEWATERING BORROW AREAS

Unless otherwise specified in Section 7, the Contractor shall maintain the borrow areas in drainable condition or otherwise provide for timely and effective removal of surface waters that accumulate, for any reason, within the borrow areas.

5. REMOVAL OF TEMPORARY WORKS

After the temporary works have served their purposes, the Contractor shall remove them or level and grade them to the extent required to present a sightly appearance and to prevent any obstruction of the flow of water or any other interference with the operation of or access to the permanent works.

Except as otherwise specified, pipes and casings shall be removed from temporary wells and the wells shall be filled to ground level with gravel or other material approved by the Engineer.

6. MEASUREMENT AND PAYMENT

For items of work for which specific lump sum prices are established in the contract, payment for diverting surface water, dewatering construction sites, and dewatering borrow areas will be made at the contract lump sum prices. Such payment will constitute full compensation for all labor, equipment, tools, and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

(11-2)

NEH 1/28/70 (Notice 20-27)



INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 12RELIEF WELLS1. Applicability.

Construction Specification 12 is applicable to the construction of pressure relief wells in foundations of structures.

2. Material Specifications.

Material Specifications 521, 553 and 554 are complementary to Construction Specification 12.

3. Items to be Included in Contract Specifications and Drawings.

- a. Plan location of each well;
- b. Profile along the line of wells showing the spacing and estimated depths of the wells;
- c. Sectional elevation of typical wells showing:
  - (1) The location of the well screens;
  - (2) The diameter and vertical extent of the filter;
  - (3) Details of the outlet at the upper end of the filter;
  - (4) Details of couplings and special fittings and appurtenances such as tees, check valves, caps and appurtenant housings.
- d. Special limits on time of installation. For example, it may be required that the relief wells be installed before any structural load is placed on the foundation or prior to a specific phase of construction.
- e. The type and size of pipe.
- f. The type and size of well screens including the size and pattern of screen openings or slots.
- g. The grading limits of the filter material.

4. Discussion of Options.

Two options are included in Sections 11 and 12. These options are self-explanatory but it must be noted that Options 1 and 2 of Section 11 are respectively complementary to Options 1 and 2 of Section 12.

CONSTRUCTION SPECIFICATION (GUIDE)12. RELIEF WELLS1. SCOPE

The work shall consist of installing and developing relief wells.

2. MATERIALS

Well screens shall be of the specified type and size, and the size and pattern of screen openings shall conform to the details shown on the drawings. Each screen shall be equipped with a bottom plug of the same material as the screen.

The riser pipe and fittings shall conform to the requirements of Material Specifications 553 or 554 for the specified type of pipe. Filter materials shall conform to the requirements of Material Specification 521 and shall be graded as specified.

3. LOCATION AND DEPTH OF WELLS

The plan location and the depth of each well shown on the drawings are based on design estimates. The final depth and location of the components of each well will be determined by the Engineer on the basis of his examination of the well log and samples recovered during drilling. The location of a well will be changed where obstructions encountered during drilling require abandonment of the well.

4. DRILLING

Unless otherwise specified, the wells shall be drilled vertically by a rotary drilling method. The diameter of each well shall be adequate to permit the placement of the specified thickness of filter. Drilling methods that may reduce the yield of the well will not be permitted.

The well shall be cased with a temporary casing of a type that:

- a. Shall have sufficient thickness to retain its shape and maintain the true section throughout its depth;
- b. Shall be removable in a manner that will not disturb the filter, well screen or riser pipe.

(12-1)

## 5. INSTALLING RISER PIPE AND SCREEN

The riser, consisting of the riser pipe, well screens, couplings and fittings, shall be measured and inspected as it is assembled and placed in the well. Spiders, or other centering devices, shall be attached to the assembled riser in sufficient numbers to center it in the well and hold it securely in position while the filter is being placed.

Before the riser is placed, filter materials shall be placed at the bottom of the well to the elevation prescribed by the Engineer for the bottom of the well screen. The riser shall be placed in the well in such a manner as to avoid shock and to prevent damage to any of its components. The relief outlet or top of the riser shall be held at the designated elevation during the placement of the filter.

## 6. PLACING FILTER

The filter shall be placed by tremie to an elevation not less than one foot above the top of the highest well screen. At the start of placement the tremie shall rest on the bottom of the well and be filled with filter material. The tremie and the temporary casing shall be raised in increments of not more than two feet allowing the filter material to flow out the bottom of the tremie. The top surface of the filter material in the tremie shall be maintained above the water surface at all times. The top surface of the filter material in the well shall be maintained at least 2 feet above the bottom of the casing as the casing is pulled.

## 7. DEVELOPING

After the filter is placed the well shall be developed by an approved method. Prior to development the Contractor shall submit his plan for accomplishing the work to the Engineer for approval.

All materials pulled into the screen during development shall be removed. Filter material shall be added to the annular space around the screen as needed to maintain the top of the filter at the specified elevation.

Any well that continues to produce appreciable amounts of fines after development for four hours will be abandoned and relocated by the Engineer.

(12-2)

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8. BACKFILLING

After the well has been developed the annular space around the riser pipe above the filter shall be filled with selected moist impervious earth fill or portland cement concrete. Backfill shall be placed in layers not over 12 inches in thickness and each layer shall be tamped firmly into place. The temporary casing shall be withdrawn in increments as the backfill is placed.

9. ABANDONED WELLS

All abandoned wells shall be plugged with either selected moist impervious earth backfill or portland cement concrete. When a well is abandoned after development the well screen and riser pipe shall be salvaged whenever possible.

10. LOGGING AND SAMPLING

The Contractor shall do the drilling in such a manner that the Engineer may take representative disturbed samples of all materials encountered.

11. MEASUREMENT

(Option 1) The amount of well drilling will be measured to the nearest foot of well drilled and cased. Wells abandoned for causes other than the fault of the Contractor will be included in the measurement for payment.

The amounts of filter and backfill placed will be computed to the nearest 0.1 cubic yard from measurement of the vertical well space occupied by each and the outside diameters of the casing and riser. Filter and backfill in wells abandoned for causes other than the fault of the Contractor will be included in the measurement for payment.

The amounts of pipe and well screen installed in the riser and outlet assembly will be measured to the nearest linear foot at the time the riser is assembled. Pipe and well screen that cannot be salvaged from wells abandoned for causes other than the fault of the Contractor will be included in the measurement for payment.

The number of couplings and special fittings and appurtenances will be counted at the time the riser is assembled. Couplings and special fittings and appurtenances that cannot be salvaged from wells abandoned for causes other than the fault of the Contractor will be included in the measurement for payment.

(12-3)

The time required to develop each well will be measured to the nearest half hour. Time required to develop wells abandoned for causes other than the fault of the Contractor will be included in the measurement for payment.

(Option 2) The amount of well drilling will be measured to the nearest foot of well drilled and cased. Wells abandoned for causes other than the fault of the Contractor will be included in the measurement for payment.

The amount of each grading of filter placed will be computed to the nearest 0.1 cubic yard from measurement of the vertical well space occupied by each and the diameters of the casing and riser. Filter in wells abandoned for causes other than the fault of the Contractor will be included in the measurement for payment.

The amounts of pipe, couplings, fittings, appurtenances and well screen installed in the riser and outlet assembly will be measured to the nearest linear foot at the time the riser is assembled. Pipe, couplings, fittings, appurtenances and well screen that cannot be salvaged from wells abandoned for causes other than the fault of the Contractor will be included in the measurement for payment.

The time required to develop each well will be measured to the nearest half hour. Time required to develop wells abandoned for causes other than the fault of the Contractor will be included in the measurement for payment.

Backfill will not be measured.

## 12. PAYMENT

(Option 1) Payment for each item of work will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work included in the item.

Payment for drilling and casing each size of well will be made at the contract unit price for that size of well and will include compensation for drilling, casing, pulling casing and costs of moving on and off the work site.

Payment for furnishing and placing filter will be made at the contract unit price for that grading of filter material.

(12-4)

Payment for furnishing and placing backfill will be made at the contract unit price.

Payment for furnishing and installing each type and size of pipe will be made at the contract unit price for that type and size of pipe.

Payment for furnishing and installing each type and size of well screen will be made at the contract unit price for that type and size of well screen.

Payment for furnishing and installing each coupling will be made at the contract unit price for that type and size of coupling.

Payment for each special fitting or appurtenance will be made at the contract unit price for that type and size of fitting or appurtenance.

Payment for developing each well will be made at the contract unit price for developing that size of well.

(Option 2) Payment for each item of work will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work included in the item.

Payment for drilling, casing and backfilling each size of well will be made at the contract unit price for that size of well and will include compensation for drilling, casing, pulling casing, and backfilling.

Payment for furnishing and placing filter will be made at the contract unit price for that grading of filter material.

Payment for furnishing and installing each type and size of pipe complete with all couplings, fittings and appurtenances (except well screens) will be made at the contract unit price for that type and size of pipe.

Payment for furnishing and installing each type and size of well screen will be made at the contract unit price for that type and size of well screen.

Payment for developing each well will be made at the contract unit price for developing that size of well.

(12-5)

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(Use with Either Option) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 13 of this specification.

(12-6)

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 13PILING1. Applicability.

Construction Specification 13 is applicable to the furnishing and installing of timber piles, steel piles, precast concrete piles and shells for cast-in-place piles. It is not applicable to the installation of drilled, cast-in-place piles.

2. Material Specifications.

Material Specifications 511, 512, 513, and 514 are complementary to Construction Specification 13.

3. Items to be Included in Contract Specifications and Drawings.

- a. Plan showing the location of all piles, including test piles, if any.
- b. Foundation profiles and sections showing:
  - (1) Logs of borings, including penetration test results;
  - (2) Required or estimated pile penetration;
  - (3) Cutoff elevations.
- c. Required bearing capacities. [Note: Specify (1) required bearing capacity or (2) required penetration or (3) required bearing capacity and minimum penetration, as appropriate.]
- d. For timber piles state the type, class, species and length of piles required. For Type I piles, also state where the piles will be inspected. For Type II piles, also state the type of treatment and minimum retention of preservative per cubic foot of pile.
- e. Details of precast or cast-in-place concrete piles including dimensions, reinforcement details, class of concrete, size of aggregate, type of cement and slump required.
- f. Nominal size and weight of section for H bearing piles.
- g. Authorization to use gravity hammers, if appropriate.

- h. Details of load tests that will be required, if appropriate.
- i. Methods of measurement and payment if the standard specification includes more than one method.

4. Discussion of Options.

Section 12, Measurement and Payment.

- (1) Options 1, 2, 4, and 5 are intended for use when a considerable number of piles of about the same length are required. Option 1 requires only one pay item but does not allow for payment for piles furnished until driving is completed. Option 2 requires two pay items and allows for payment for piles delivered and stockpiled. Options 4 and 5 differ from Options 1 and 2, respectively, only in that they provide for separate payment for mobilization and demobilization of equipment. When the cost of moving equipment onto and off of the work site is a major cost (in relation to the number of piles to be driven) the use of Options 4 and 5 is preferred.
- (2) Options 3 and 6 may be used when the lengths of piles required may be quite variable. They are particularly suitable where the cutoff portions of the piles may be salvaged and used on the job, such as when steel bearing piles are specified. Option 6 differs from Option 3 only in that it provides for separate payment for mobilization and demobilization of equipment.
- (3) Option 7 may be used for sheet pile walls when the required depth of penetration is known.
- (4) Two or more options may be included as numbered methods in standard specifications. If numbered methods are used, insert the following paragraph before the fourth paragraph from the end of the section:

All Methods. The following provisions apply to all methods of measurement and payment.

CONSTRUCTION SPECIFICATION (GUIDE)13. PILING1. SCOPE

The work shall consist of furnishing and driving the specified kinds and types of piles at the locations shown on the drawings.

2. MATERIALS

Piles shall conform to the requirements of Material Specifications 511, 512, 513, or 514 as appropriate to the kinds of piles specified.

3. SITE PREPARATION

All excavation within the area to be occupied by bearing piles shall be completed before the piles are driven.

4. PROTECTION OF PILE HEADS

The heads of all piles shall be protected during driving by suitable caps, rings, heads, blocks, mandrels and other devices.

The heads of timber piles shall be fitted into a steel head block or fitted with heavy steel or wrought iron rings or wire wrapping.

The heads of steel piles shall be cut square and fitted with a steel driving cap.

The heads of precast concrete piles and casings shall be fitted into cushion type drive caps having a rope or other suitable cushion next to the pile head and fitting into a casting which in turn supports a timber shock block.

Driving heads, mandrels and other devices shall be provided by the Contractor as needed for special types of piles and shall conform to the recommendations of the pile manufacturer.

5. DRIVING BEARING PILES

Piles shall be driven only in the presence of the Engineer.

The piles shall be driven to the position, line and batter specified on the drawings. Each pile shall be driven continuously and without interruption to the specified depth or until the specified

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bearing capacity is obtained. Deviation from this procedure will be permitted only when interruption of driving is caused by conditions that could not reasonably be anticipated.

Unless otherwise approved, piles shall be driven with steam, air or diesel powered hammers or a combination of hammers and water jets. Water jets may be used only when specifically authorized by the Engineer. Where jetting is authorized, the jets shall be withdrawn before the specified depth or bearing capacity is reached and the piles shall be driven with the hammer to the final penetration.

When drop hammers are permitted, the height of drop shall be not more than 8 feet for concrete piles or 12 feet for steel or timber piles.

Piles shall not be driven within 20 feet of concrete less than 7 days old, including concrete placed in cast-in-place piles with or without predriven shells or casings.

The driving of piling with followers shall be allowed only when expressly approved by the Engineer.

Diesel hammers shall be operated with throttles fully open when blows are counted for determination of bearing capacity except that throttle adjustments shall be made as necessary to prevent the nonstriking parts of the hammer from rising from the pile on the ram upstroke.

The Contractor shall not attempt to drive piles beyond the point of refusal, as indicated by excessive bouncing of the hammer or kicking of the pile.

#### 6. DRIVING SHEET PILING

The piling shall be driven in such a manner as to insure perfect interlocking throughout the entire length of each pile. The piles shall be held in proper alignment during driving by means of assembling frames or other suitable temporary guide structures. Temporary guide structures shall be removed when they have served their purpose.

At any time that the forward edge of the sheet pile wall is found to be out of correct alignment: (a) the piling already assembled and partly driven shall be driven to the required depth, and (b) taper piles shall then be driven to bring the forward edge into

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correct alignment before additional regular piling is assembled and driven. The maximum permissible taper in a single pile shall be one-fourth inch per foot of length.

## 7. ESTIMATING BEARING CAPACITY

When load tests are not required, the bearing capacity of each pile shall be estimated by use of one of the following formulas, as appropriate:

- a. For gravity hammers,  $R = \frac{2WH}{S+1}$ ;
- b. For single-acting steam or air hammers and for diesel hammers having unrestricted rebound of the ram,  $R = \frac{2WH}{S+0.1}$ ;
- c. For double acting steam or air hammers and diesel hammers having enclosed rams,  $R = \frac{2H(W+AP)}{S+0.1}$ ; or,  $R = \frac{2E}{S+0.1}$ ;  
where:

R = safe bearing capacity in pounds,  
W = weight, in pounds, of striking parts of hammer,  
H = height of fall in feet,  
A = area of piston in square inches,  
P = pressure, in pounds per square inch, of steam, air or other gas exerted on the hammer piston or ram,  
E = the manufacturers rating for foot-pounds of energy developed by double-acting steam or air hammers, or 90 percent of the average equivalent energy, in foot-pounds, developed by diesel hammers having enclosed rams as evaluated by gauge and chart readings.  
S = average penetration, inches per blow, for the last 5 to 10 blows of a gravity hammer or the last 10 to 20 blows for steam, air or diesel powered hammers.

The above formulas are applicable only when:

- a. The hammer has a free fall
- b. The head of the pile is not crushed
- c. The penetration is reasonably quick and uniform

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- d. There is no sensible bounce after the blow
- e. A follower is not used.

Twice the height of the bounce shall be deducted from "H" to determine its value in the formula.

In case water jets are used in connection with the driving, the bearing power shall be determined by the above formulas from the results of driving after the jets have been removed.

## 8. LOAD TESTS

When load tests are specified, the test loads shall be applied gradually, without impact, and in such a way that no lateral forces are applied to the pile. Load testing shall not be started until 24 hours after driving of the test pile is completed, or such longer time as is specified. Except as otherwise specified, load tests shall be made according to the following procedure:

The total test load shall be twice the specified working load and shall be applied to the pile in increments equal to 25 percent of the working load. Settlement of the top of the pile shall be measured to an accuracy of 0.01 inch before and after the application of each load increment and at 2, 4, 8, 15, 30, and 60 minutes after, and then every 2 hours until the next load increment is applied. Additional load shall not be applied until the rate of settlement is less than 0.01 inch in one hour.

The total test load shall remain on the pile for a period of at least 24 hours. Settlement shall be measured at 6-hour intervals during this period and at the end of the period, at least twice during removal of the load, and immediately after all of the test load is removed. The net settlement shall be measured approximately 24 hours after all of the load has been removed.

If settlement continues in excess of 0.01 inch per hour under less than the total test load, no additional load shall be applied, but the load that has been applied shall remain on the pile for a period of at least 24 hours, and settlement measurements while the load is on the pile, and during and after removal of the load shall be made as if it were the total test load.

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## 9. CUTTING OFF PILES

The Contractor shall cut the piles off at the specified elevations. The length of pile cut off shall be sufficient to permit the removal of all damaged material. Steel shells or concrete casings for cast-in-place concrete piles shall be cut off at the specified elevation before being filled with concrete.

Steel bearing piles shall be cut off in clean, straight lines as shown on the drawings. Any irregularities shall be leveled off with deposits of weld metal or by grinding before placement of bearing caps.

Precast concrete piles and concrete casings shall be cut off in a manner such as to prevent damage to the remaining portion of the pile or casing or to the projecting reinforcement required for connecting the piles to the structure.

Timber piles that are to be capped shall be accurately cut off so that true bearing is obtained on every pile without the use of shims.

## 10. DEFECTIVE PILES

Any pile damaged in driving, driven out of its proper location, driven below the specified cut off elevation or inaccurately cut off shall be corrected by one of the following methods, whichever is approved by the Engineer:

- a. The defective pile shall be pulled and replaced or redriven;
- b. A new pile shall be driven adjacent to the defective pile; or,
- c. The defective pile shall be spliced or built up or a sufficient portion of the footing shall be extended to properly embed the pile.

Pile shells abandoned in place after driving shall be filled with concrete or sand-cement grout as appropriate to the situation.

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All piles pushed up by the driving of adjacent piles or by any other cause shall be driven down again.

Any sheet pile ruptured in the interlock or otherwise damaged during driving shall be pulled and replaced.

11. CORRECTING SURFACE HEAVE

Any excess material resulting from displacement of earth by pile driving shall be removed. Materials disturbed by pile driving shall be conditioned and compacted to a density equal to that of the adjacent undisturbed material.

12. MEASUREMENT AND PAYMENT

(Option 1) For items of work for which specific unit prices are established in the contract, the number of each type, kind and length of pile driven in place will be counted. Payment for furnishing and driving each type, kind and length of pile will be made at the contract unit price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work including moving equipment onto and off of the work site.

(Option 2) For items of work for which specific unit prices are established in the contract, the number of each type, kind, and length of pile furnished, accepted and stockpiled in good condition at the site of the work will be counted. Payment for furnishing each type, kind, and length of pile will be made at the contract unit price. Payment for driving each type and kind of pile will be made at the contract unit price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work including moving equipment onto and off of the work site.

(Option 3) For items of work for which specific unit prices are established in the contract, the length of each type and kind of pile driven will be computed to the nearest foot as the difference between the measured length of pile before driving and measured length of pile cut off after driving. Payment for furnishing and driving each type and kind of pile will be made at the contract unit price. Such payment will constitute full payment for all labor, materials, equipment and all other items necessary and incidental to the completion of the work, including moving equipment onto and off of the work site.

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(Option 4) For items of work for which specific unit prices are established in the contract, the area of sheet pile walls, acceptably placed, will be computed to the nearest square foot within the neat lines shown on the drawings. Payment will be made at the contract unit price for each type, kind, and weight of piling. Such payment will constitute full payment for all labor, materials, equipment, and all other items necessary and incidental to the completion of the work.

(Use with All Options) The measurement of the number of linear feet of piles (or number of piles) furnished and the number of piles driven shall include test and tension piles specified in the contract but not those furnished and driven by the Contractor at his own option. No payment will be made for furnishing or driving piles, including test piles, to replace piles lost or damaged prior to the completion of the contract while in stockpile or during handling and driving.

When load tests are specified, payment for each test will be made at the contract price per test. Such payment will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to making the test except furnishing and driving piling.

When splices are specified, payment for each splice will be made at the contract unit price. Such payment shall constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 13 of this specification.

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 14PRESSURE GROUTING1. Applicability

Construction Specification 14 is applicable to the drilling and pressure grouting of structure foundations with portland cement grout.

2. Material Specifications

Material Specifications 522 and 531 are complementary to Construction Specification 14.

3. Items to be Included in Contract Specifications and Drawings

- a. Plan and profile of the grouting layout. (Include region to be grouted, location and spacing of lines and holes, depth of holes, and location of drill holes used in the geologic investigation.)
- b. Inclination of holes (angle to vertical) if inclined holes are required.
- c. Location and depth of exploratory holes to be drilled.
- d. Details of testing and sampling in overburden if required. (Include method of measurement and payment.)
- e. Location and placement details of capping concrete if required.
- f. Method of grouting (stage or packer).
- g. Area boundaries and depth intervals for stage grouting. Depth intervals for packer grouting.
- h. Design pressures at the collar for various grout mixes and various depth intervals.
- i. Limitations and requirements on the sequence of drilling and grouting.
- j. Minimum distance to be maintained between grouting and drilling operations, and minimum age of grout at which drilling in grouted holes or adjacent to grouted holes will be permitted.

- k. Minimum distance between grouted area and blasting site and minimum permissible age of grout at blasting time, if applicable.
- l. Minimum distance of grout and water injections to concrete structures and drains.
- m. Type of cement to be used in grout.
- n. Type and quality of admixtures.
- o. Type and quality of bulk fillers.
- p. Pollution prevention measures, such as lagoons to retain grout from leakages and from flushing of lines and equipment and any other measures or precautions required to prevent pollution of natural streams or other bodies of water, above or below ground, with grout, toxic dyes, oil, fuel, or other substances harmful to humans, wildlife, or plants.
- q. A statement in the Special Provisions that (1) the quantity variations clause of the General Provisions or the Special Provisions (depending on where the quantity variations clause is located in the particular contract) shall not apply to items of work under Construction Specification 14. Pressure Grouting, (2) there is no guarantee as to the quantities of such items, and (3) payment will be made at the contract prices for such items regardless of the quantities of the items actually used or performed.



CONSTRUCTION SPECIFICATION (GUIDE)14. PRESSURE GROUTING1. SCOPE

The work shall consist of drilling grout holes and exploratory holes, pressure testing, and injecting portland cement grout under pressure, and shall include furnishing all material, labor, and equipment required in accomplishment of the work.

2. EQUIPMENT

All drilling and grouting equipment shall be of a type and capacity, and in condition, to carry out the work described.

Drilling Equipment. For exploratory holes, all drilling equipment used in rock shall be of the rotary type, shall be equipped with hydraulic feed, and, when specified, shall be capable of drilling angle holes up to 30 degrees from vertical.

Cores shall be drilled with standard ball bearing, swivel type, double tube, split core barrels, or non-split barrels of the "M" series.

Equipment for drilling grout holes may be of the rotary type. No core recovery will be required, and the type of bit used shall be optional. Equipment using air for flushing cuttings shall not be used. Percussion drilling equipment using water for flushing cuttings may be used if approved by the Contracting Officer, in which case the lifting rate of the flushing water shall be not less than 18 inches per second.

Grouting Equipment. The grouting equipment shall be capable of mixing, storing, and pumping grout as specified.

Pumps. Grout pumps shall be of the long stroke, multiple piston or the helical screw type. The capacity shall be not less than 20 gpm at 200 psi.

Mixers. Mixers shall be designed to mix cement, water, and bulk fillers thoroughly and to produce a grout of uniform texture at the specified mix ratios. Mixers shall match the capacity of the pumping plant.

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Hold-over Tank. A hold-over tank shall be furnished if a single compartment mixer is used. It shall be equipped with mechanical agitators to prevent segregation of the grout, and shall have sufficient capacity to provide a continuous supply of grout. The outflow shall pass through a No. 16 wire mesh screen if the grout contains particles or foreign matter that would interfere with its proper flow into the spaces it is intended to fill.

Air Supply. The air supply shall meet the requirement of the pumps and shall be not less than 200 cubic feet per minute per plant.

Water Meter. One water meter, of the reset type, graduated in tenths of gallons or hundredths of cubic feet shall be used with each mixer.

Pressure Gages. One pressure gage shall be installed at the pump and one at the collar of the hole. Gages shall be of the nonclogging type or shall be prevented from clogging by using gage-savers or grease. Spare gages shall be at hand at all times.

Hoses, Valves, and Fittings. Hoses, valves, and fittings shall be compatible with the maximum pressures specified. Hose from pump to grout header and return shall be not smaller than 1 1/2 inch (ID), and the pipe between header and packer shall be not smaller than 3/4 inch (ID). Double or single packers may be required for grouting and pressure testing. Packers shall fit tightly in the holes at all testing and grouting pressures.

### 3. ARRANGEMENT OF GROUTING EQUIPMENT

The arrangement of grouting equipment shall provide a return line from the header back to the pump or hold-over tank, permitting continuous circulation of the grout. The grout pressure shall be controlled at the header or at the end of the return line.

Each hole shall be equipped with a hole shut-off valve below the hand coupling union, permitting shut-off at refusal pressure and removal of the header to another hole while still maintaining pressure in the completed hole.

The header arrangement shall include a blow-off valve and a control valve, to be used to check back-pressure in the hole prior to

removal of the header to another hole while still maintaining pressure in the completed hole.

The header arrangement shall include a blow-off valve and a control valve, to be used to check back-pressure in the hole prior to removal of the header, and a valve in the return line. The header shall be connected to the supply line by means of a U-shaped pipe arrangement which prevents fall-out of solids into the hole from the bypassing grout when the rate of grout acceptance is small.

#### 4. COMMUNICATIONS

A suitable communications system between individuals at the pump units and the holes shall be maintained by the Contractor.

#### 5. MATERIALS

Portland Cement. Portland cement shall conform to the requirements of Material Specification 531 for the specified type. If the cement contains lumps or foreign material which would clog the grouting equipment or interfere with grout injection, it shall be screened through a 100-mesh screen. Cement shall be furnished in bags (94 lbs.) unless special equipment is provided for storing, handling, and weighing bulk cement as specified in Section 2.

Water. Water used shall be clean and free from injurious amounts of oil, acid, organic matter, or other deleterious substances. The temperature of the water at time of mixing shall be above 50°F.

Sand. Sand for grout shall conform to Material Specification 522 except that, unless specified otherwise, the gradation shall be as follows:

<u>Sieve Designation</u> <u>(U.S. Std. Square Mesh)</u>	<u>Percent Passing</u> <u>by Weight</u>
16	100
50	20-50
100	10-30
200	0-5

Sand included in the mix shall be measured in cubic foot boxes unless otherwise approved by the Engineer.

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Bulk Fillers. Bulk fillers other than sand shall be of the type and quality specified in Section 18. Bulk fillers included in the mix shall be measured in cubic foot boxes unless otherwise approved by the Engineer.

Admixtures. Admixtures shall be of the type and quality specified in Section 18.

Storage and Supply. A sufficient quantity of all materials shall be on hand to insure that grouting operations will not be interrupted or delayed. Materials shall be stored in such a manner that the quality of the materials is maintained.

## 6. GROUT MIXTURES

Composition. Grout shall consist of a mixture of portland cement and water. Sand, bulk filler, and admixtures shall be included as specified.

Grout mixes and sequences of changes in mix ratio or composition shall be as specified in Section 14 except as otherwise directed by the Engineer.

Mix Ratios. Grout mix ratios will be expressed in cubic feet of water to a bag of cement. Bulk fillers will be expressed in cubic feet to a bag of cement. Other additives will be expressed in pounds, gallons, or pints to a bag of cement.

## 7. CAPPING CONCRETE

Concrete for grout caps, if required, shall be placed as shown on the drawings. The concrete shall be a workable mixture of portland cement, fine and coarse aggregates, and water, containing not less than 6 bags of cement per cubic yard of concrete, and not more than 6 gallons of water per bag of cement, including the free moisture in the aggregates.

Portland cement shall conform to the requirements of Material Specification 531 for the type specified. Aggregates shall consist of sound and durable particles and shall conform to the limitations for deleterious substances and the grading requirements of ASTM Specification C 33. Coarse aggregates shall be size number 7, 67, 57, or 467 as defined in ASTM Specification C 33.

Batching, mixing, and placing shall be done in a manner that will produce a uniform, well-graded, dense concrete. When ready-mixed concrete

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is furnished, the Contractor shall furnish the Engineer a delivery ticket showing the time of loading and the quantities of materials used for each load of concrete. Concrete shall be placed within 1½ hours after introduction of the cement to the aggregates.

Surfaces against which concrete is to be placed shall be cleaned of soil, loose rock, and other loose material by air-water cutting, jetting, or other means as necessary, and shall be moist when the concrete is placed.

Concrete shall be placed only when the Engineer is present.

The concrete shall be prevented from drying for a curing period of at least 5 days after it is placed. Exposed surfaces shall be kept continuously moist for the entire period, or shall be coated with an acceptable curing compound as soon as free water has disappeared.

#### 8. DRILLING OVERBURDEN

Unless otherwise specified, holes drilled through overburden shall be cased. The inside diameter of the casing shall be not less than 3 1/16 inches for exploratory holes or 2 1/2 inches for grout holes. Casings shall be removed after completion of the grouting operations unless otherwise approved by the Engineer. Holes in overburden shall be backfilled with grout or a sand-cement mixture or by tamping soil into the holes to approximately the density of the surrounding overburden, unless otherwise specified or directed by the Engineer.

#### 9. DRILLING ROCK

The location, inclination, and depth of holes shall be as shown on the drawings except as otherwise directed by the Engineer.

The use of rod dope, grease, and other solid or liquid lubricants will not be permitted.

The Contractor shall perform such exploratory drilling as may be required to determine the condition of the rock prior to grouting and the effectiveness of the grouting operation as the work progresses. All exploratory holes shall be cored and shall be pressure tested when directed by the Engineer. Exploratory holes shall have a diameter of not less than 2.9 inches and a core diameter of not less than 2.1 inches (NX). Rock core samples shall be carefully placed in correct sequence in labeled core boxes furnished by

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the Contractor, and shall be stored at the job site where they will be safe and readily accessible to the Contracting Officer for his use and disposal.

Grout holes shall have a diameter of not less than 1.4 inches (EX).

The Contractor shall temporarily discontinue drilling in case of excessive water loss and shall pressure test and/or grout the hole as directed by the Engineer.

#### 10. PRESSURE TESTING

In holes to be pressure tested, the packer or packers shall be set at intervals as directed by the Engineer. Each interval shall be tested at water pressures up to the specified design grouting pressure for that interval, unless otherwise directed by the Engineer. Pressures exceeding the specified design pressures shall not be applied unless specifically authorized by the Engineer.

The flow shall be read at one-minute intervals. When the absorption is steady for at least three consecutive minutes at the maximum pressure for the interval being tested, the shut-off valve at the hole shall be turned off and the pressure drop shall be observed. The flow readings and the rate of pressure drop shall be recorded.

Pressure test equipment shall be calibrated at the site to determine the pressure loss in the equipment at various flow rates and test depths.

Pressure tests and calibration of pressure test equipment shall be performed in the presence of the Engineer.

#### 11. STAGE GROUTING

Stage grouting shall be done in successive depth intervals (stages) in each hole, beginning at the surface and progressing to the deeper stages. All of the holes in a specified area shall be drilled and grouted in each stage before grouting of the succeeding stage is begun.

The stages and the grouting pressures for each stage shall be as specified, except as otherwise directed by the Engineer.

Washing with water and air shall precede grouting in each stage. Washing under pressure or pressure testing shall be performed as specified or as directed by the Engineer.

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12. PACKER GROUTING

If packer grouting is specified, the holes shall be drilled to the specified depths and shall be grouted in intervals starting at the bottom.

The grouting intervals and pressures shall be as specified, except as otherwise directed by the Engineer.

Prior to grouting, the entire hole shall be washed with a mixture of water and air. Washing under pressure or pressure testing shall be performed as specified or as directed by the Engineer.

13. GROUT INJECTION

Grout pressures shall not exceed the specified design pressures unless specifically authorized by the Engineer.

Grouting, particularly in zones near the surface, shall be done with extreme caution to prevent uplift of the rock or excessive leakage of grout at the surface.

The Contractor shall caulk surface leaks which cause excessive loss of grout or prevent reaching required grouting pressures. Leaks may be caulked by mechanical means or with fast-setting mortar. If necessary, grouting shall be temporarily suspended or the pressure shall be reduced to permit the caulking of leaks. Accelerators may be added to the grout for the same purpose if approved by the Engineer.

If grout injected into one hole appears in adjacent holes, they shall be plugged temporarily with packers set just above the level at which the grout is entering while grouting of the particular interval of the first hole is being completed.

The quantity of grout prepared in advance shall be kept to a minimum. Grout which has been kept in the mixer with or without agitation for longer than one hour shall be discarded.

Grout temperatures shall be not lower than 50°F. The grouted soil, rock, or concrete shall be not colder than 40°F when grout is injected and for at least 48 hours thereafter. Insulative protection or heat shall be applied to the surface

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for 24 hours prior and 48 hours after grouting if needed to keep the soil, rock, or concrete at the required temperature.

#### 14. GROUTING PROCEDURE

The procedures described below are general guidelines and may be altered in the field by the Engineer to suit the conditions encountered and to meet the design objectives. Changes in the grout mix and grouting procedure shall be made when and as directed by the Engineer, and shall not be made without the approval of the Engineer.

Grouting at each elevation in each hole shall start with a 5:1 mix (5 cu. ft. water: 1 bag cement). If the specified design pressure cannot be reached at an absorption rate of not more than 10 gpm, the mix ratio shall be changed progressively to thicker mixes, after three batches of 5:1 mix (about 5.45 cu. ft. per batch), until a ratio has been reached at which the hole refuses to accept grout at the specified pressure.

When the hole shows signs of refusal, a thinner mix shall be used to prevent or remove clogging. Preferably the last mix ratio prior to refusal in each hole shall be 3:1 or thinner.

A hole shall be considered grouted when absorption at the design pressure is less than 5-7 gallons of grout in 10 minutes.

If a hole continues to accept grout when the mix has been thickened to a ratio of 1:1, the mix shall be thickened further with sand or other bulk fillers after three batches of 1:1 mix have been injected.

If it continues to accept grout after a reasonable amount of the thickest workable grout mixture has been injected, the Engineer may specify a reduced pump speed and/or the use of accelerators, or may direct that the pumping be halted temporarily to permit the grout to set.

Grouting shall be discontinued in holes which do not respond to this procedure and the holes shall be redrilled and re-grouted later, or the area of high grout absorption shall be grouted from adjacent holes until the design objective has been achieved.

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15. RECORDS

When drilling overburden and when drilling exploratory holes the Contractor shall keep an accurate drilling log which includes, where applicable, a record of the ground water level in the hole.

The Contractor shall keep a complete and accurate record of all grouting operations. This record shall include a time log of the grout mixes and admixtures used in each stage or interval of each hole, the related pressures and absorption rates, back pressures, and observations on excessive leakage and other non-routine conditions.

One copy of the records shall be furnished to the Engineer at the end of each shift, or as directed.

16. CLEANUP

After grouting is completed, the Contractor shall remove the grouting plant and all related parts, equipment, and supplies from the site, including unused materials and waste that is unsightly or would interfere with efficient operation by others.

17. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices or lump sum prices are established in the contract, measurement and payment for pressure grouting will be made as described below. Such payment will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to the completion of the work.

Mobilization. If mobilization for pressure grouting is shown as a separate item of work in the contract, payment for mobilization will be made at the contract lump sum price. Such payment will include compensation for moving grouting equipment and supplies to the site of the work, assembling the plant at the site, moving on the site as work progresses, and removal from the site upon completion of the work. Sixty percent of the lump sum price will be paid when the plant is assembled at the site and work is begun. The remaining forty percent will be paid after the work is completed, the plant is removed from the site, and cleanup is completed.

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Drilling Overburden. Drilling overburden will be measured by determining, to the nearest foot, the total linear feet of accepted hole drilled in the overburden. Payment for drilling overburden will be made at the contract unit price which will include compensation for placing and removing casings.

Drilling Rock. Drilling rock will be measured by determining, to the nearest foot, the total linear feet of accepted hole of each size drilled in rock without coring. Payment for drilling rock will be made at the contract unit price for each size of hole.

Coring Rock. Coring rock will be measured by determining, to the nearest foot, the total linear feet of accepted hole of each size cored in rock. Payment for coring rock will be made at the contract unit price for each core size which will include compensation for furnishing and handling the core boxes, storing cores and recording observations as specified.

Pressure Tests. Pressure testing will be measured by determining the total time, to the nearest one-quarter hour, that pressure is applied to the holes in making the required tests. One-quarter hour will be added for setting up equipment for each test. No extra payment will be made for calibrating pressure test equipment. Payment for pressure tests will be made at the contract unit price.

Connections to Grout Holes. Connections to grout holes will be measured by determining the number of connections made of the grout supply hose to the holes to be grouted. The number of connections for payment will not exceed one per hole for packer grouting or one for each stage for stage grouting, except that if grouting is interrupted to permit the grout to set, one additional connection will be measured for payment each time grouting at the same elevation in the same hole is resumed. Payment for connections to grout holes will be made at the contract unit price.

Placing Grout. Grout placed will be measured to the nearest cubic foot by counting the number of batches of each grout mixture injected in the holes as specified and multiplying by the number of cubic feet per batch. The number of cubic feet per batch for each grout mixture will be determined as the average of the measured volumes of at least three (3) batches of the mixture. Payment for placing grout will be

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made at the contract unit price which will include compensation for handling all materials for the purpose of mixing and placing grout, washing the holes with air and water, sealing surface leaks, and maintaining grout records. Payment will not be made for grout lost by failure of the Contractor to caulk surface leaks or for grout otherwise wasted through the fault of the Contractor.

Cement. Cement for grout will be measured on the basis of the number of bags of cement (94 lbs.) or equivalent weight of bulk cement used in the grout. Cement used in concrete for capping or other purposes will not be included. Payment for cement will be made at the contract unit price. Payment will not be made for cement in grout wasted because of mechanical failure or through the fault of the Contractor.

Sand and Bulk Fillers. Sand and bulk fillers will be measured by volume to the nearest cubic foot of each used in the grouting operation. Payment for sand will be made at the contract unit price. Payment for bulk fillers will be made at the contract unit price for each type of bulk filler specified. Payment will not be made for sand or bulk fillers wasted because of mechanical failure or through the fault of the Contractor.

Admixtures. Liquid admixtures will be measured by volume to the nearest gallon. Dry admixtures will be measured by weight to the nearest pound. Payment for admixtures will be made at the contract unit price for each type of admixture specified. Payment will not be made for admixtures wasted because of mechanical failure or through the fault of the Contractor.

Capping Concrete. Capping concrete will be measured to the nearest 0.1 cubic yard by determining the combined weights of cement, aggregates, and water used in concrete mixed and placed as specified, and dividing by a unit weight of 4000 pounds per cubic yard. Payment for capping concrete will be made at the contract unit price which will include compensation for furnishing and handling all materials, including cement, and for mixing, transporting, placing, and curing the concrete.

Subsidiary Items. Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 18 of this specification.

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 21EXCAVATION1. Applicability.

Construction Specification 21 is applicable to all types of excavation. The specification defines classes of excavation and includes special requirements for certain types of excavation but does not establish and define all types of excavation. It is intended that the types of excavation be established on a job or project basis as needed.

The "class" of excavation defines the kind of material to be excavated. The "type" of excavation defines the functional purpose of the excavation. Established types of excavation may include (but are not restricted to):

- a. Foundation Excavation (or Stripping);
- b. Cutoff Trench Excavation;
- c. Channel Excavation;
- d. Structure Excavation;
- e. Emergency Spillway Excavation;
- f. Abutment Shaping Excavation.

Any of the established types may include excavation of materials in either class or may be unclassified. However, the excavation of a given class of material may be more difficult in one type of excavation than in another. These factors must be carefully considered as a basis for establishing types of excavation to be designated on the drawings and listed in the bid schedule.

For projects involving considerable quantities of excavation of different classes of material under conditions that vary in different parts of the works, bids must be asked, and payments made, on the basis of both type and class of excavation. For such projects it is necessary that the bid schedule be set up in terms of both type and class of excavation (for example: Channel Excavation, Common; Channel Excavation, Rock).

For projects involving only one type of excavation and for projects involving small quantities of excavation it may be sufficient to include only the classes of excavation in the bid schedule.

2. Material Specifications.

There are no material specifications complementary to Construction Specification 21.

3. Items to be Included in Contract Specifications and Drawings.

- a. The horizontal and vertical extent of each type of excavation.
- b. Designation and definition of types of excavation.
- c. Excavation pay limits when Option 1, Section 11, is used.
- d. Surface finish requirements, such as grading tolerances.  
(This may be especially important at the crest of a spillway.)
- e. The location and limits of all borrow areas.
- f. The location and limits of all waste areas.
- g. Boring logs or test pit logs pertinent to all areas to be excavated. In addition to descriptions of materials, logs must also include water table elevations and dates of observation. For purposes of the construction drawings, no indications of correlation of materials between logs shall be shown.
- h. Existing access and haul roads.
- i. Special requirements for dewatering and keeping the excavation dry, with cross reference to Construction Specification 11 where applicable.
- j. Special requirements for control of blasting if applicable.
- k. Special requirements for control of erosion, water pollution and air pollution if applicable.
- l. Requirements for control of the size gradation of excavated rock where necessary in order to obtain material of a particular gradation for rock fill or riprap.



- n. Methods of measurement and payment, if the standard specification includes more than one method.
- m. Requirements for concrete to fill voids from overexcavation (refer to specification 31 or 32) if requirements in Section 10 are not adequate.

#### 4. Discussion of Options.

##### a. Section 5, Use of Excavated Materials

- (1) Option 1 is intended for use when the quality, condition and relative location of significant quantities of the materials to be excavated are known to be suited to the economic construction of the required fill, and particularly where alternate sources of material are less desirable or do not exist.
- (2) Option 2 is intended for use when the known data indicate that the use of alternate sources of fill materials may result in more economical construction of the required fill.

##### b. Section 6, Disposal of Waste Materials

- (1) Option 1 is intended for use when areas for wasting fill are available at the site, when the waste fill will beneficially supplement the function of the permanent works or when there is no known market for the sale of such waste materials as may be produced.
- (2) Option 2 is intended for use when areas for wasting fill are not readily available at the site or when there is a known market for the sale of such waste materials as may be produced.

##### c. Section 11, Measurement and Payment

- (1) Option 1 is intended for excavations where the pay limits can best be defined on the drawings.
- (2) Option 2 is intended for excavations bounded by simple plane surfaces and constant or gradually varying cross section throughout.
- (3) Option 3 is intended for excavations whose lower limits are determinable only by examination of the materials encountered and where the lower limits have been designated on the drawings as approximate or "to be determined by the Engineer during construction."

- (4) Option 4 is intended for structure excavation bounded by fairly simple plane surfaces where pay limits are not shown on the drawings.
- (5) Two or more options may be included as numbered methods in standard specifications.



CONSTRUCTION SPECIFICATION (GUIDE)21. EXCAVATION1. SCOPE

The work shall consist of the excavation required by the drawings and specifications and disposal of the excavated materials.

2. CLASSIFICATION

Excavation will be classified as common excavation or rock excavation in accordance with the following definitions or will be designated as unclassified.

Common excavation shall be defined as the excavation of all materials that can be excavated, transported, and unloaded by the use of heavy ripping equipment and wheel tractor-scrapers with pusher tractors or that can be excavated and dumped into place or loaded onto hauling equipment by means of excavators having a rated capacity of one cubic yard and equipped with attachments (such as shovel, bucket, backhoe, dragline or clam shell) appropriate to the character of the materials and the site conditions.

Rock excavation shall be defined as the excavation of all hard, compacted or cemented materials the accomplishment of which requires blasting or the use of excavators larger than defined for common excavation. The excavation and removal of isolated boulders or rock fragments larger than one cubic yard in volume encountered in materials otherwise conforming to the definition of common excavation shall be classified as rock excavation.

Excavation will be classified according to the above definitions by the Engineer, based on his judgment of the character of the materials and the site conditions.

The presence of isolated boulders or rock fragments larger than one cubic yard in size will not in itself be sufficient cause to change the classification of the surrounding material.

For the purpose of this classification, the following definitions shall apply:

(21-1)

Heavy ripping equipment shall be defined as a rear-mounted, heavy duty, single-tooth, ripping attachment mounted on a tractor having a power rating of 200-300 net horsepower (at the flywheel).

Wheel tractor-scraper shall be defined as a self-loading (not elevating) and unloading scraper having a struck bowl capacity of 12-20 yards.

Pusher tractor shall be defined as a track type tractor having a power rating of 200-300 net horsepower (at the flywheel) equipped with appropriate attachments.

### 3. UNCLASSIFIED EXCAVATION

Items designated as "Unclassified Excavation" shall include all materials encountered regardless of their nature or the manner in which they are removed. When excavation is unclassified, none of the definitions or classifications stated in Section 2 of this specification shall apply.

### 4. BLASTING

The transportation, handling, storage, and use of dynamite and other explosives shall be directed and supervised by a person of proven experience and ability in blasting operations.

Blasting shall be done in such a way as to prevent damage to the work or unnecessary fracturing of the foundation and shall conform to any special requirements in Section 12 of this specification.

### 5. USE OF EXCAVATED MATERIALS

(Option 1) To the extent they are needed, all suitable materials from the specified excavations shall be used in the construction of required permanent earth fill or rock fill. The suitability of materials for specific purposes will be determined by the Engineer. The Contractor shall not waste or otherwise dispose of suitable excavated materials.

(Option 2) Suitable materials from the specified excavations may be used in the construction of required earth fill or rock fill. The suitability of materials for specific purposes will be determined by the Engineer.

(21-2)

## 6. DISPOSAL OF WASTE MATERIALS

(Option 1) All surplus or unsuitable excavated materials will be designated as waste and shall be disposed of at the locations shown on the drawings.

(Option 2) All surplus or unsuitable excavated materials will be designated as waste and shall be disposed of by the Contractor at sites of his own choosing away from the site of the work.

## 7. BRACING AND SHORING

Excavated surfaces too steep to be safe and stable if unsupported shall be supported as necessary to safeguard the work and workmen, to prevent sliding or settling of the adjacent ground, and to avoid damaging existing improvements. The width of the excavation shall be increased if necessary to provide space for sheeting, bracing, shoring, and other supporting installations. The Contractor shall furnish, place and subsequently remove such supporting installations.

## 8. STRUCTURE AND TRENCH EXCAVATION

Structure or trench excavation shall be completed to the specified elevations and to sufficient length and width to include allowance for forms, bracing and supports, as necessary, before any concrete or earth fill is placed or any piles are driven within the limits of the excavation.

## 9. BORROW EXCAVATION

When the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified fills, additional materials shall be obtained from the designated borrow areas. The extent and depth of borrow pits within the limits of the designated borrow areas shall be as directed by the Engineer.

Borrow pits shall be excavated and finally dressed in a manner to eliminate steep or unstable side slopes or other hazardous or unsightly conditions.

## 10. OVEREXCAVATION

Excavation in rock beyond the specified lines and grades shall be corrected by filling the resulting voids with portland cement concrete made of materials and mix proportions approved by the Engineer. Concrete that will be exposed to the atmosphere when

(21-3)



construction is completed shall contain not less than 6 sacks of cement per cubic yard of concrete. Concrete that will be permanently covered shall contain not less than  $4\frac{1}{2}$  sacks of cement per cubic yard. The concrete shall be placed and cured as specified by the Engineer.

Excavation in earth beyond the specified lines and grades shall be corrected by filling the resulting voids with approved compacted earth fill, except that, if the earth is to become the subgrade for riprap, rock fill, sand or gravel bedding, or drain fill, the voids may be filled with material conforming to the specifications for the riprap, rock fill, bedding or drain fill.

#### 11. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of each type and class of excavation within the specified pay limits will be measured and computed to the nearest cubic yard by the method of average cross-sectional end areas. Regardless of quantities excavated, the measurement for payment will be made to the specified pay limits, except that excavation outside the specified lines and grades directed by the Engineer to remove unsuitable material will be included, but only to the extent that the unsuitable condition is not a result of the Contractor's operations.

(Option 1) The pay limits shall be as designated on the drawings.

(Option 2) The pay limits shall be defined as follows:

- a. The upper limit shall be the original ground surface as it existed prior to the start of construction operations except that where excavation is performed within areas designated for previous excavation or fill the upper limit shall be modified ground surface resulting from the specified previous excavation or fill.
- b. The lower and lateral limits shall be the neat lines and grades shown on the drawings.

(Option 3) The pay limits shall be defined as follows:

- a. The upper limit shall be the original ground surface as it existed prior to the start of construction operations except that where excavation is performed within areas designated

(21-4)



for previous excavation or fill the upper limit shall be the modified ground surface resulting from the specified previous excavation or fill.

- b. The lower and lateral limits shall be the true surface of the completed excavation as authorized by the Engineer.

(Option 4) The pay limits shall be defined as follows:

- a. The upper limit shall be the original ground surface as it existed prior to the start of construction operations except that where excavation is performed within areas designated for previous excavation or fill the upper limit shall be the modified ground surface resulting from the specified previous excavation or fill.
- b. The lower limit shall be at the bottom surface of the proposed structure.
- c. The lateral limits shall be 18 inches outside of the outside surfaces of the proposed structure or shall be vertical planes 18 inches outside of and parallel to the footings, whichever gives the larger pay quantity, except as provided in d, below.
- d. For trapezoidal channel linings or similar structures that are to be supported upon the sides of the excavation without intervening forms, the lateral limits shall be at the under side of the proposed lining or structure.
- e. For the purpose of the definitions in b, c, and d, above, any specified bedding or drain fill directly beneath or beside the structure will be considered to be a part of the structure.

(Use with All Options) Payment for each type and class of excavation will be made at the contract unit price for that type and class of excavation. Such payment will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to the performance of the work, except that extra payment for backfilling required overexcavation will be made in accordance with the following provisions:

- a. Payment for backfilling overexcavation, as specified in Section 10 of this specification, will be made only if the excavation outside specified lines and grades is directed by the Engineer to remove unsuitable material and if the unsuitable condition is not a result of the Contractor's operations.

(21-5)

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 12 of this specification.

(21-6)

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 23EARTH FILL1. Applicability

Construction Specification 23 is applicable to all types of earth fill including fill constructed of rocky soils and fill constructed of soft or friable rock which is expected to break down during compaction.

2. Material Specifications

There are no material specifications complementary to Construction Specification 23.

3. Items to be Included in the Contract Specifications and Drawings

- a. Complete plans and cross sections of the required fills.
- b. Pay limits where applicable.
- c. Borrow areas or other sources of material.
- d. Designation and description of the types of materials required in the various parts of the work.
- e. Maximum allowable size of rock particles.
- f. Special requirements for foundation preparation.
- g. Maximum layer thickness before compaction. (Table A-23 may be used as a guide. Table A-23 gives upper limits for the general classes of material listed. The specified maximum layer thickness may have to be substantially less than the tabulated value to obtain adequate compaction.)
- h. Maximum layer thickness for fill compacted by manually directed power tampers. (The maximum thickness that can be adequately compacted depends upon the tampers and upon the soil being placed, varying from about 4 inches for plastic clays to about 8 inches for coarse grained material of low plasticity.)
- i. Special instructions for sectional or phase construction where applicable.
- j. Allowable range of moisture content for each item. For example:

- (1) "The moisture content of the fill matrix at the time of compaction shall be neither less than 2 percent below optimum moisture content nor more than 2 percent above optimum moisture content."
  - (2) "The moisture content of the fill material shall be maintained within the limits required to:
    - (a) prevent bulking or dilatance of the material under the action of the hauling or compacting equipment; (b) prevent the adherence of the fill material to the treads and tracks of the equipment; and (c) insure the crushing and blending of the soil clods and aggregations into a reasonably homogeneous mass."
- k. Compaction class for each item. (Table A-23 may be used as a guide.)
  - l. For Class A compaction: Compaction test method and required percent of maximum density. Typical compaction test results if applicable.
  - m. For Class B compaction: Minimum mass density.
  - n. For Class C compaction: Type of roller; minimum weight or contact pressure of roller; minimum vibrating force and frequency for vibrating roller; minimum number of passes.
  - o. Special requirements for backfilling and compacting adjacent to structures if applicable, including instructions regarding forms or other supports which must be left in place until the concrete attains its specified 28-day strength.
  - p. Required minimum strength of concrete, determined according to Section 6, for starting compaction of backfill adjacent to structures, if applicable.
  - q. Methods of measurement and payment if the standard specification includes more than one method.
  - r. Embedded structures whose volume will be excluded from the earth fill volume for payment. (In general, the embedded volume of conduits over 48 inches in inside diameter and other structures of comparable size should be deducted.)
  - s. Special requirements pertaining to furnishing and applying water, including designated source and details of ownership and water rights if applicable, and including water quality requirements if quality may be a problem.



- s. Special requirements for control of erosion, water pollution, and air pollution, if applicable.

#### 4. Discussion of Options.

##### a. Section 9, Measurement and Payment.

- (1) Option 1 is intended for structure backfill and other cases where pay limits can best be shown on the drawings.
- (2) The selected options for pay limits must be compatible with those selected for use in Construction Specification 21.
- (3) Option 6 or 7 must be used with any or all options 1 through 5.
- (4) Option 6 is intended for use when no separate payment is to be made for water.
- (5) Option 7 is intended for use with Construction Specification 10 when the Contractor is to be paid under a separate item for the water needed to bring the fill materials to the specified moisture content.
- (6) Two or more options may be included as numbered methods in the standard specifications. If numbered methods are used, insert the following paragraph after the last of the numbered methods:

All Methods. The following provisions apply to all methods of measurement and payment.

TABLE A-23

Grading Characteristics of Fill Material		Appropriate Compaction Classes	Maximum Layer Thickness* (Before Compaction)			
% > No. 4	% Fines		Tamping Roller	Pneum. Roller	Vibrating Roller	40000 lb. Tractor
0 - 35	Over 5	A	9"	9"	24"	---
	Under 5	A B, C	9" --	12" 18"	24" 30"	--- 12"
35 - 65	25 - 50	A B, C	9" 9"	12" 18"	24" 24"	--- ---
	5 - 25	A B, C	-- --	12" 18"	24" 24"	--- ---
Over 65	Under 5	B, C	--	24"	36"	18"
	Over 5	B, C	--	18"	24"	---
Over 65	Under 5	B, C	--	24"	36"	18"
	Over 5	B, C	--	18"	24"	---
Materials such as shales, schists, disintegrated granite, soft sandstone, siltstone.		Depends upon the degree of breakdown under the action of the excavating and compacting equipment.	Must be determined on the basis of special laboratory tests or field compaction tests or both. Test fills may be needed.			

SOILS

WEATHERED OR  
WEAKLY IN-  
DURATED ROCK  
MATERIALS

\*NOTE: Tabulated values are upper limits. Actual maximum layer thickness for uniform compaction of a given material may be substantially lower. Maximum size of rock fragments should not exceed 2/3 of the layer thickness.

CONSTRUCTION SPECIFICATION (GUIDE)23. EARTH FILL1. SCOPE

The work shall consist of the construction of earth embankments and other earth fills required by the drawings and specifications.

2. MATERIALS

All fill materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing and disposition of materials in the various fills shall be subject to approval by the Engineer.

Fill materials shall contain no sod, brush, roots or other perishable materials. Rock particles larger than the maximum size specified for each type of fill shall be removed prior to compaction of the fill.

The types of materials used in the various fills shall be as listed and described in the specifications and drawings.

3. FOUNDATION PREPARATION

Foundations for earth fill shall be stripped to remove vegetation and other unsuitable materials or shall be excavated as specified.

Except as otherwise specified, earth foundation surfaces shall be graded to remove surface irregularities and shall be scarified parallel to the axis of the fill or otherwise acceptably scored and loosened to a minimum depth of 2 inches. The moisture content of the loosened material shall be controlled as specified for the earth fill, and the surface materials of the foundation shall be compacted and bonded with the first layer of earth fill as specified for subsequent layers of earth fill.

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of two inches in depth normal to the slope and shall be at such a moisture content that the earth fill can be compacted against them to effect a good bond between the fill and the abutments.

Rock foundation and abutment surfaces shall be cleared of all loose materials by hand or other effective means and shall be

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free of standing water when fill is placed upon them. Occasional rock outcrops in earth foundations for earth fill, except in dams and other structures designed to restrain the movement of water, shall not require special treatment if they do not interfere with compaction of the foundation and initial layers of the fill or the bond between the foundation and the fill.

Foundation and abutment surfaces shall be not steeper than 1 horizontal to 1 vertical unless otherwise specified. Test pits or other cavities shall be filled with compacted earth fill conforming to the specifications for the earth fill to be placed upon the foundation.

#### 4. PLACEMENT

Fill shall not be placed until the required excavation and foundation preparation have been completed and the foundation has been inspected and approved by the Engineer. Fill shall not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the fill.

Fill shall be placed in approximately horizontal layers. The thickness of each layer before compaction shall not exceed the maximum thickness specified. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified thickness before being compacted. Hand compacted fill, including fill compacted by manually directed power tampers, shall be placed in layers not more than 4 inches thick before compaction.

Adjacent to structures, fill shall be placed in a manner which will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly. The height of the fill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure.

Earth fill in dams, levees and other structures designed to restrain the movement of water shall be placed so as to meet the following additional requirements:

- a. The distribution of materials throughout each zone shall be essentially uniform, and the fill shall be free from lenses, pockets, streaks or layers of material differing substantially in texture or gradation from the surrounding material.

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- b. If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2 inches before the next layer is placed.
- c. The top surfaces of embankments shall be maintained approximately level during construction, except that a crown or cross-slope of not less than 2 percent shall be maintained to insure effective drainage, and except as otherwise specified for drain fill zones. If the drawings or specifications require or the Engineer directs that fill be placed at a higher level in one part of an embankment than another, the top surface of each part shall be maintained as specified above.
- d. Dam embankments shall be constructed in continuous layers from abutment to abutment except where openings to facilitate construction or to allow the passage of stream flow during construction are specifically authorized in the contract.
- e. Embankments built at different levels as described under c or d above shall be constructed so that the slope of the bonding surfaces between embankment in place and embankment to be placed is not steeper than 3 feet horizontal to 1 foot vertical. The bonding surface of the embankment in place shall be stripped of all loose material, and shall be scarified, moistened and recompacted when the new fill is placed against it as needed to insure a good bond with the new fill and to obtain the specified moisture content and density in the junction of the in place and new fill.

## 5. CONTROL OF MOISTURE CONTENT

During placement and compaction of fill, the moisture content of the materials being placed shall be maintained within the specified range.

The application of water to the fill materials shall be accomplished at the borrow areas insofar as practicable. Water may be applied by sprinkling the materials after placement on the fill, if necessary. Uniform moisture distribution shall be obtained by discing, blading or other approved methods prior to compaction of the layer.

Material that is too wet when deposited on the fill shall either be removed or be dried to the specified moisture content prior to compaction.

If the top surface of the preceding layer of compacted fill or a foundation or abutment surface in the zone of contact with the fill becomes too dry to permit suitable bond it shall be scarified and moistened by sprinkling to an acceptable moisture content prior to placement of the next layer of fill.

(23-3)

## 6. COMPACTION

Earth fill shall be compacted according to the following requirements for the class of compaction specified:

Class A compaction. Each layer of fill shall be compacted as necessary to make the density of the fill matrix not less than the minimum density specified. The fill matrix is defined as the portion of the fill material finer than the maximum particle size used in the compaction test method specified.

Class B compaction. Each layer of fill shall be compacted to a mass density not less than the minimum density specified.

Class C compaction. Each layer of fill shall be compacted by the specified number of passes of the type and weight of roller or other equipment specified, or by an approved equivalent method. Each pass shall consist of at least one passage of the roller wheel or drum over the entire surface of the layer.

Fill adjacent to structures shall be compacted to a density equivalent to that of the surrounding fill by means of hand tamping or manually directed power tampers or plate vibrators. Heavy equipment shall not be operated within 2 feet of any structure. Vibrating rollers shall not be operated within 5 feet of any structure. Compaction by means of drop weights operating from a crane or hoist will not be permitted.

The passage of heavy equipment will not be allowed: (1) over cast-in-place conduits prior to 14 days after placement of the concrete; (2) over cradled precast conduits prior to 7 days after placement of the concrete cradle; or (3) over any type of conduit until the backfill has been placed above the top surface of the structure to a height equal to one-half the clear span width of the structure or pipe or 2 feet, whichever is greater.

Compacting of fill adjacent to structures shall not be started until the concrete has attained the strength specified in Section 10 for this purpose. The strength will be determined by compression testing of test cylinders cast by the Engineer for this purpose and cured at the work site in the manner specified in ASTM Method C 31 for determining when a structure may be put into service.

When the required strength of the concrete is not specified as described above, compaction of fill adjacent to structures shall not be started until the following time intervals have elapsed after placement of the concrete.

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<u>Structure</u>	<u>Time Interval</u>
Retaining walls and counterforts	14 days
Walls backfilled on both sides simultaneously	7 days
Conduits and spillway risers, cast-in-place (with inside forms in place)	7 days
Conduits and spillway risers, cast-in-place (inside forms removed)	14 days
Conduits, precast, cradled	2 days
Conduits, precast, bedded	1 day
Antiseep collars and cantilever outlet bents	3 days

7. REMOVAL AND PLACEMENT OF DEFECTIVE FILL

Fill placed at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the requirements or removed and replaced by acceptable fill. The replacement fill and the foundation, abutment and fill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control and compaction.

8. TESTING

During the course of the work, the Engineer will perform such tests as are required to identify materials, to determine compaction characteristics, to determine moisture content, and to determine density of fill in place. These tests performed by the Engineer will be used to verify that the fills conform to the requirements of the specifications. Such tests are not intended to provide the Contractor with the information required by him for the proper execution of the work and their performance shall not relieve the Contractor of the necessity to perform tests for that purpose.

Densities of fill requiring Class A compaction will be determined by the Engineer in accordance with ASTM Method D 1556 (or by equivalent methods), except that the volume and moist weight of included rock particles larger than those used in the compaction test method specified for the type of fill will be determined and deducted from the volume and moist weight of the total sample prior to computation of density. The density so computed will be used to determine the percent compaction of the fill matrix.

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## 9. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of each type and compaction class of earth fill within the specified zone boundaries and pay limits will be measured and computed to the nearest cubic yard by the method of average cross-sectional end areas. Unless otherwise specified, no deduction in volume will be made for embedded conduits and appurtenances.

The pay limits shall be as defined below, with the further provision that earth fill required to fill voids resulting from overexcavation of the foundation, outside the specified lines and grades, will be included in the measurement for payment only where such overexcavation is directed by the Engineer to remove unsuitable material and where the unsuitable condition is not a result of the Contractor's operations.

(Option 1) The pay limits shall be as designated on the drawings.

(Option 2) The pay limits shall be the measured surface of the foundation when approved for placement of the fill and the specified neat lines of the fill surface.

(Option 3) The pay limits shall be the measured surface of the foundation when approved for placement of the fill and the measured surface of the completed fill.

(Option 4) The pay limits shall be the specified pay limits for excavation and the specified neat lines of the fill surface.

(Option 5) The pay limits shall be the specified pay limits for excavation and the measured surface of the completed fill.

(Use option 6 or 7 with all options 1 through 5)

(Option 6) Payment for each type and compaction class of earth fill will be made at the contract unit price for that type and compaction class of fill. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work.

(Option 7) Payment for each type and compaction class of earth fill will be made at the contract unit price for that type and compaction class of fill. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work, except furnishing, transporting, and applying water to the foundation and fill materials.

(23-6)

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Water applied to the foundation and fill materials will be measured and payment will be made as specified in Construction Specification 10.

(Use with All Options) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 10 of this specification.



INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 24DRAIN FILL1. Applicability.

Construction Specification 24 is applicable to the placing of drain fill in all types of structure drains and filters, such as:

- a. Drainage systems installed beneath concrete structures, linings or pavements;
- b. Wall drains for concrete structures;
- c. Embankment drains and filter zones;
- d. Interceptor drains installed adjacent to structures;
- e. Foundation drains.

2. Material Specifications.

Material Specification 521 is complementary to Construction Specification 24.

3. Items to be Included in Contract Specifications and Drawings.

- a. The location, extent, and dimensions of each drain or filter.
- b. The grading limits of each type of drain fill.
- c. The source of drain fill materials, when applicable.
- d. Specifications for control of moisture if required. If water is to be added and is to be included in a separate pay item for water, add the statement: Water applied to the fill material will be measured and payment will be made as specified in Construction Specification 10.
- e. Class of compaction. Also specify the weight and number of passes of the compacting equipment required, if more than the minimum amounts specified in Section 6. (Class A provides for control of compaction by relative density of the fill. Classes I, II and III specify the method of compaction. Relative density tests during construction usually should be made in connection with the method specifications to evaluate the compaction being accomplished. Class I is intended for use where highest densities are required, Class II is intermediate, and Class III may be used for wall drains in uncompacted backfill or for other applications where strength is not important.)



4. Discussion of Options.

Section 2, Materials.

- (1) Option 1 is intended for use in specifications for drains that are required to function throughout the life of the structure or to function as filters in relation to adjacent materials and are not accessible for maintenance should hazardous malfunction occur. Drains and drainage blankets under concrete structures, foundation trench drains and embankment drainage blankets often fall in this category.
- (2) Option 2 is intended to be used in specifications for drains that are required to function only in the first phase of the life of the structure or that are not required to function as filters in relation to adjacent materials. Some types of foundation drains and embankment drainage blankets fall in this category. This option may also be used for permanent drains when the quality of the materials has previously been determined to be suitable (by adequate sampling and testing).

CONSTRUCTION SPECIFICATION (GUIDE)24. DRAIN FILL1. SCOPE

The work shall consist of furnishing, placing and compacting drain fill required in the construction of structure drains and filters.

2. MATERIALS

(Option 1) Drain fill materials shall conform to the requirements of Material Specification 521. At least 30 days prior to delivery of the materials to the site the Contractor shall inform the Contracting Officer in writing of the source from which he intends to obtain them. The Contractor shall provide the Engineer free access to the source for the purpose of obtaining samples for testing.

(Option 2) Drain fill materials shall be sand, gravel or crushed stone or mixtures thereof obtained from the specified sources. They shall be selected as necessary to avoid the inclusion of organic matter, clay balls, excessive fine particles or other substances that would interfere with their free-draining properties.

3. BASE PREPARATION

Foundation surfaces and trenches shall be clean and free of organic matter, loose soil, foreign substances, and standing water when the drain fill is placed. Earth surfaces upon or against which drain fill will be placed shall not be scarified.

4. PLACEMENT

Drain fill shall not be placed until the subgrade has been inspected and approved by the Engineer. Drain fill shall not be placed over or around pipe or drain tile until the installation of the pipe or tile has been inspected and approved.

Drain fill shall be placed uniformly in layers not more than 12 inches deep before compaction. When compaction is accomplished by manually controlled equipment, the layers shall be not more than 8 inches deep. The material shall be placed in a manner to avoid segregation of particle sizes and to insure the continuity and integrity of all zones. No foreign materials shall be allowed to become intermixed with or otherwise contaminate the drain fill.

(24-1)

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Traffic shall not be allowed to cross over drains at random. Equipment crossovers shall be maintained, and the number and location of such crossovers shall be established and approved prior to the beginning of drain fill placement. Each crossover shall be cleaned of all contaminating materials and shall be inspected and approved by the Engineer before additional drain fill is placed.

Any damage to the foundation surface or to the sides or bottoms of trenches occurring during placement of drain fill shall be repaired before drain fill placement is continued.

The upper surface of drain fill constructed concurrently with adjacent zones of earth fill shall be maintained at an elevation at least one foot above the upper surface of the adjacent fill.

Drain fill over or around pipe or drain tile shall be placed in a manner to avoid any displacement of the pipe or tile in line or grade.

#### 5. CONTROL OF MOISTURE

The moisture content of drain fill materials shall be controlled as specified in Section 8. When the addition of water is required, it shall be applied in such a way as to avoid excessive wetting of adjacent earth fill. Except as specified in Section 8, control of the moisture content will not be required.

#### 6. COMPACTION

Drain fill shall be compacted according to the following requirements for the class of compaction specified:

Class A compaction. Each layer of drain fill shall be compacted to a relative density of not less than 70 percent as determined by ASTM Method D 2049-64T.

Class I compaction. Each layer of drain fill shall be compacted by at least 2 passes, over the entire surface, of a steel-drum vibrating roller weighing not less than 5 tons and exerting a vertical vibrating force of not less than 20,000 pounds at least 1200 times per minute, or by an approved equivalent method.

Class II compaction. Each layer of drain fill shall be compacted by one of the following methods or by an approved equivalent method:

(24-2)



- a. At least 2 passes, over the entire surface, of a pneumatic-tired roller exerting a pressure of not less than 75 pounds per square inch.
- b. At least 4 passes, over the entire surface, of the track of a crawler-type tractor weighing not less than 20 tons.
- c. Controlled movement of the hauling equipment so that the entire surface is traversed by not less than one tread track of the loaded equipment.

Class III compaction. No compaction will be required beyond that resulting from the placing and spreading operations.

When compaction other than Class III compaction is specified materials placed in trenches or other locations inaccessible to heavy equipment shall be compacted by means of manually controlled pneumatic or vibrating tampers or by approved equivalent methods.

#### 7. TESTING

The Engineer will perform such tests as are required to verify that the drain fill materials and the drain fill in place meet the requirements of the specifications. These tests are not intended to provide the Contractor with the information he needs to assure that the materials and workmanship meet the requirements of the specifications, and their performance will not relieve the Contractor of the responsibility of performing his own tests for that purpose.

#### 8. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of drain fill within the neat lines shown on the drawings or limits established by the Engineer will be measured and computed to the nearest cubic yard. Where the Engineer directs placement of drain fill outside the neat lines to replace unsuitable foundation material, the volume of such drain fill will be included, but only to the extent that the unsuitable condition is not a result of the Contractor's operations.

Payment for drain fill will be made at the contract unit price for each type of drain fill, complete in place. Except as otherwise specified in Section 9, such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work.

(24-3)

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Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 9 of this specification.

(24-4)

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 25ROCK FILL1. Applicability.

Construction Specification 25 is applicable to rock fill constructed of hard, durable rock with sufficiently open grading to drain freely. It does not apply to riprap slope protection nor to earth fill constructed of rocky soils or of soft rock which is expected to break down during compaction.

2. Material Specifications.

There are no material specifications complementary to Construction Specification 25.

3. Items to be Included in Contract Specifications and Drawings.

- a. Complete plans and cross sections of the required fills.
- b. Zoning plans, including gradation requirements for materials in each zone.
- c. Specifications for bedding.
- d. Pay limits where applicable.
- e. The source of each type of fill.
- f. Screening or other processing requirements.
- g. Specifications for wetting during placement and compaction if required. If water is to be added and is to be included in a separate pay item for water, add the statement: Water applied to the fill material will be measured and payment will be made as specified in Construction Specification 10.
- h. Class of compaction. Also specify more passes or heavier equipment if test fills or other sources of information indicate the need for it. (Class I is intended for use where the highest degree of compaction is required, Class II is intermediate, and Class III is for use where no special compaction is needed.)

4. Discussion of Options.

Section 5, Placement.

- (1) Option 1 is intended for use whenever the grading of materials within the fill is not a critical element of the design.
- (2) Option 2 is intended for use when the piping or cracking potential of the core zone is a critical element of the design or when the percentage of large rock is relatively low and special slope protection is desired.

CONSTRUCTION SPECIFICATION (GUIDE)25. ROCK FILL1. SCOPE

The work shall consist of the construction of rock fill zones of embankments and other rock fills required by the drawings and specifications, including bedding where specified.

2. MATERIALS

Materials for rock fill and bedding shall be obtained from the specified sources. They shall be excavated, selected, processed, and handled as necessary to conform to the specified grading limits.

3. FOUNDATION PREPARATION

Foundations for rock fill shall be stripped to remove vegetation and other unsuitable materials or shall be excavated as specified.

Except as otherwise specified, earth foundation surfaces shall be graded to remove surface irregularities, and test pits or other cavities shall be filled with compacted earth fill of approximately the same kind and density as the adjacent foundation material.

Rock foundation surfaces shall be cleared of all loose materials not conforming to the specifications for the rock fill.

Abutments for rock fill zones of embankments shall be prepared as specified above for foundations.

4. BEDDING

When a bedding layer beneath rock fill is specified, the bedding material shall be spread uniformly on the prepared subgrade surfaces to the depth indicated. Compaction of the bedding will not be required but the surface of such layers shall be finished free from mounds, dips or windrows.

5. PLACEMENT

(Option 1) No fill or bedding shall be placed until foundation preparation is completed and the foundation and excavations have been inspected and approved by the Engineer.

(25-1)

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The rock shall be dumped and spread into place in approximately horizontal layers not more than 3 feet in thickness. It shall be placed in a manner to produce a reasonably homogeneous stable fill that contains no segregated pockets of large or small fragments or large unfilled spaces caused by bridging of the larger fragments.

(Option 2) No fill or bedding shall be placed until foundation preparation is completed and the foundation and excavations have been inspected and approved by the Engineer.

The rock shall be dumped and spread into place in approximately horizontal layers not more than 3 feet in thickness. The rock shall be placed so that the completed fill shall be graded with the smaller rock fragments placed in the inner portion of the embankment and the larger rock fragments placed on the outer slopes. It shall be placed in a manner that will produce a stable fill that contains no large unfilled spaces caused by bridging of the larger fraction.

#### 6. CONTROL OF MOISTURE

The moisture content of rock fill materials shall be controlled as specified in Section 9. When the addition of water is required it shall be applied in such a way as to avoid excessive wetting of adjacent earth fill. Except as specified in Section 9, control of the moisture content will not be required.

#### 7. COMPACTION

Rock fill shall be compacted as described below for the class of compaction specified or by an approved equivalent method.

Class I compaction. Each layer of fill shall be compacted by at least 4 passes, over the entire surface, of a steel-drum vibrating roller weighing not less than 5 tons and exerting a vertical vibrating force of not less than 20,000 pounds at least 1200 times per minute.

Class II compaction. Each layer of fill shall be compacted by at least 4 passes, over the entire surface, of the track of a crawler-type tractor weighing not less than 20 tons.

Class III compaction. No compaction will be required beyond that resulting from the placing and spreading operations.

(25-2)

## 8. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of each type of rock fill, including bedding, within the zone boundaries and limits specified on the drawings or established by the Engineer will be measured and computed to the nearest cubic yard by the method of average cross-sectional end areas.

Payment for each type of rock fill will be made at the contract unit price for that type of fill. Except as otherwise specified in Section 9, such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work, including furnishing and placing the bedding.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 9 of this specification.



INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 26SALVAGING AND SPREADING TOPSOIL1. Applicability.

Construction Specification 26 is applicable to the salvaging and spreading of topsoil to parts of the construction site for the purpose of establishing vegetative cover for erosion control and aesthetic improvement. It may apply to final dressing of slopes of earth fills, borrow areas, channels or other features. It should only be specified where the surface horizon of the soil is considered more suitable for supporting plant growth than the exposed subsoil or fill and its use is more economical than other means of conditioning the exposed subsoil or fill.

2. Material Specifications.

There are no material specifications complementary to Construction Specification 26.

3. Items to be Included in Contract Specifications and Drawings.

- a. Limits of source areas for obtaining topsoil.
- b. Limits of areas on which topsoil is to be spread.
- c. Depth of topsoil layer to be spread.
- d. Limits of stockpile areas, if critical.

4. Discussion of Options.

The options are self-explanatory.

Two or more options may be included as numbered methods in standard specifications. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

All Methods. The following provisions apply to all methods of measurement and payment.



# THE HISTORY OF THE CITY OF BOSTON

The city of Boston, situated on a peninsula in the State of Massachusetts, was first settled in 1630 by a group of Puritan settlers. The city grew rapidly and became one of the most important centers of commerce and industry in the New England region. It was the site of the Boston Tea Party in 1773, a key event in the American Revolution. The city was also the site of the Boston Massacre in 1770, another key event in the Revolution. The city's history is marked by its role in the American Revolution and its subsequent growth as a major center of commerce and industry.

The city of Boston has a long and rich history, and its role in the American Revolution is a key part of its identity. The city was the site of the Boston Tea Party in 1773, a key event in the American Revolution. The city was also the site of the Boston Massacre in 1770, another key event in the Revolution. The city's history is marked by its role in the American Revolution and its subsequent growth as a major center of commerce and industry. The city's history is a testament to the resilience and strength of the American people.

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CONSTRUCTION SPECIFICATION (GUIDE)26. SALVAGING AND SPREADING TOPSOIL1. SCOPE

The work shall consist of salvaging topsoil from borrow pits or required excavations and spreading it on the areas shown on the drawings to the specified depths.

2. QUALITY OF TOPSOIL

Topsoil shall consist of friable surface soil reasonably free of grass, roots, weeds, sticks, stones or other foreign materials.

3. EXCAVATION

After the site has been cleared and grubbed the topsoil shall be removed from the designated areas and shall be stockpiled at locations approved by the Engineer. Objectionable materials encountered during excavation shall be removed and buried at locations approved by the Engineer or otherwise removed from the construction site.

4. SPREADING

(Option 1) Spreading shall not be done when the ground or topsoil is frozen, excessively wet or otherwise in a condition detrimental to the work. Surfaces designated to be covered shall be lightly scarified just prior to the spreading operation.

After placement is completed the surface of the topsoil shall be finished to a reasonably smooth surface.

(Option 2) Spreading shall not be done when the ground or topsoil is frozen, excessively wet or otherwise in a condition detrimental to the work. Surfaces designated to be covered shall be lightly scarified just prior to the spreading operation. Where compacted fills are designated to be covered by topsoil, the topsoil shall be placed concurrently with the fill and shall be bonded to the compacted fill with the compacting equipment.

After placement is completed the surface of the topsoil shall be finished to a reasonably smooth surface.

(26-1)

5. MEASUREMENT AND PAYMENT

(Option 1) The total area of the surfaces covered by topsoil will be computed to the nearest square yard. Payment for salvaging and placing topsoil will be made at the contract unit price. Such payment will constitute full compensation for all materials, labor and equipment and all other items necessary and incidental to the completion of the work, including excavating, stockpiling, hauling, and spreading.

(Option 2) The total area of the surfaces covered by topsoil will be computed to the nearest square yard except that the areas of the surfaces of embankments, levees, dikes and other earth fills will not be included for payment. Payment for salvaging and placing topsoil will be made at the contract unit price. Such payment will constitute full payment for all materials, labor and equipment and all other items necessary and incidental to the completion of the work, including excavating, stockpiling, hauling, and spreading.

Payment for topsoil spread on the surfaces of embankments, levees, dikes and other earth fills will be considered as included in the payment for the item of earth fill under which the embankment, levee, dike or other earth fill is constructed.

(Option 3) For items of work for which specific unit prices are established in the contract, the volume of topsoil salvaged and spread will be measured by cross section surveys of the stockpile from which it is taken if it is stockpiled; otherwise, of the area from which it is borrowed; and will be computed to the nearest cubic yard by the method of average cross-sectional end areas. Payment for salvaging and spreading topsoil will be made at the contract unit price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work, including excavating, stockpiling, hauling, and spreading.

(Use with All Options) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 6 of this specification.

(26-2)

INSTRUCTIONS FOR THE USE OF CONSTRUCTION SPECIFICATION 31CONCRETE1. Applicability.

Construction Specification 31 is applicable to the usual types of concrete construction entailed in Service operations. Supplementary specifications will be required for works of a special nature, such as:

- a. Placing concrete under water.
- b. Pumping concrete.
- c. Concrete exposed to sea water.
- d. Concrete exposed to alkali soils or alkaline water.
- e. Special finishes.

Good examples of such specifications are contained in Standard Specifications for Highway Bridges, AASHTO.

2. Material Specifications.

The following specifications are complementary to Construction Specification 31:

- a. Cement. Specification 531
- b. Aggregates. Specification 522
- c. Curing Compounds. Specification 534
- d. Preformed Joint Filler. Specification 535
- e. Metal Waterstops. Specification 538
- f. Metal. Specification 581
- g. Water-Reducing, Set-Retarding Admixtures. Specification 533
- h. Air-Entraining Admixtures. Specification 532
- i. Non-Metallic Waterstops. Specification 537



### 3. Items to be Included in Contract Specifications and Drawings.

- a. Complete engineering and structural detail drawings of the structure. (See Section 6, National Engineering Handbook.)
- b. Type, size and quality of joint filler, waterstops and shear plates.
- c. Notation of the type and quality of concrete, including:
  - (1) Class of concrete.
  - (2) Type of cement.
  - (3) Nominal size of coarse aggregate; or specification for aggregate if Material Specification 522 does not apply.
  - (4) Types of admixtures, if any.
  - (5) Deviations, if any, from the air content and slump specified in Section 4. (The air content specified in Section 4 may not be reduced for structures where the average annual minimum air temperature is below 20°F. A map showing average annual minimum temperatures for the mid-continental states may be found in "Climate and Man," the 1941 Yearbook of Agriculture, p. 707.)
- d. Deviations, if any, from specifications requiring:
  - (1) Impervious membrane under concrete placed on drain fill.
  - (2) Placement of slab concrete in a single layer.
  - (3) Consolidation of concrete with vibrators.
- e. Minimum time for removal of inside forms for spillway riser if less than 14 days and if option 1 is used in Section 18. (A minimum time less than 14 days, but not less than 3 days, may be specified for a riser or portions of a riser that, with reasonable certainty, will not be subjected to water loading within 14 days after the concrete is placed.)
- f. Required minimum strength of concrete when forms are removed if option 2 is used in Section 18.
- g. Notation calling for carborundum rubbing or similar abrasive treatment of formed surfaces exposed to view, if desired.

### 4. Discussion of Options.

- a. Section 3, Classes of Concrete

The rubbing shall be started as soon as possible after the forms are removed, patching is finished, and the patching mortar has set thoroughly. Rubbing shall be continued until all form marks, projections and irregularities have been removed and a uniform surface has been obtained. After rubbing is completed the surface shall be washed to remove loose powder and shall be left free from unsound patches, paste, powder, and objectionable marks.")

4. Discussion of Options.

a. Section 3, Classes of Concrete

- (1) Option 1 is intended for use when strength is to be used as one of the criteria for acceptance of the concrete and the Contractor is to be made responsible for the mix.
- (2) Option 2 is intended for use when the concrete mix is to be prescribed by the Engineer and strength will not govern acceptance from the Contractor.

b. Section 5, Design of the Concrete Mix

- (1) Option 1 is required with Option 1 in Section 3.
- (2) Option 2 is required with Option 2 in Section 3.

c. Section 15, Construction Joints

- (1) Option 1 is intended for use in circumstances where maximum bond between old and new concrete is desired. When such joint treatment is specified it is permissible to design horizontal construction joints as flat plane surfaces without shear keys or shear plates. Option 1 is preferred for all structures that are continuously or intermittently exposed to water. Where the joint will be subject to differential water pressure, a shear plate is recommended.
- (2) Option 2 is intended for use in circumstances where bond between old and new concrete is not a critical element. When such joint treatment is specified, the design of horizontal construction joints must incorporate shear plates if differential water pressure can possibly exist across the joint.

d. Section 18, Removal of Forms

- (1) Option 1 is intended for use when operations are not controlled on the basis of results of tests on job-cured test cylinders.
- (2) Option 2 is intended for use when operations are controlled on the basis of results of tests on job-cured test cylinders.

e. Section 25, Measurement and Payment

- (1) Option 1 is intended for use when the design and control of the concrete mix is the responsibility of the Contractor (that is, when the compressive strength of the concrete is one of the criteria determining acceptability).
- (2) Option 2 is intended for use when the job mix is designed and controlled by the Engineer.



CONSTRUCTION SPECIFICATION (GUIDE)31. CONCRETE1. SCOPE

The work shall consist of furnishing, forming, placing, finishing and curing portland cement concrete as required to build the structures named in Section 26 of this specification.

2. MATERIALS

Portland cement shall conform to the requirements of Material Specification 531 for the specified type. One brand only of any type of cement shall be used in any single structure as defined in Section 26.

Aggregates shall conform to the requirements of Material Specification 522 unless otherwise specified. The grading of coarse aggregates shall be as specified in Section 26.

Water used in mixing or curing concrete shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter or other deleterious substances.

Air-entraining admixtures shall conform to the requirements of Material Specification 532. If air-entraining cement is used, any additional air-entraining admixture shall be of the same type as that in the cement.

Water-reducing, set-retarding admixtures shall conform to the requirements of Material Specification 533.

Shear plates shall conform to the requirements of Material Specification 581 for structural quality or commercial or merchant quality steel. Structural quality shall be used if specifically designated in the drawings or specifications.

Preformed expansion joint filler shall conform to the requirements of Material Specification 535.

Waterstops shall conform to the requirements of Material Specifications 537 and 538 for the specified kinds.

Curing compound shall conform to the requirements of Material Specification 534.

(31-1)

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3. CLASSES OF CONCRETE(Option 1)

Concrete shall be classified according to the required compressive strength. The strength of the concrete at 28 days shall equal or exceed the Minimum Compressive Strength at 28 days tabulated below for the class of concrete specified.

<u>Class of Concrete</u>	<u>Minimum Compressive Strength at 28 days (psi)</u>
5000	5000
4000	4000
3000	3000
2500	2500

(Option 2)

Concrete shall be classified as follows:

<u>Class of Concrete</u>	<u>Maximum Net Water Content (gallons/bag)</u>	<u>Minimum Cement Content (bags/cu. yd.)</u>
5000X	5	7
4000X	6	6
3000X	7	5
2500X	8	4 1/2

4. AIR CONTENT AND CONSISTENCY

Unless otherwise specified the air content (by volume) of the concrete at the time of placement shall be:

<u>Maximum Size Aggregate</u>	<u>Air Content (%)</u>
3/8 inch to 1/2 inch	6 to 9
Over 1/2 inch to 1 inch	5 to 8
Over 1 inch to 2 1/2 inches	4 to 7

The consistency of the concrete shall be such as to allow it to be worked into place without segregation or excessive laitance. Unless otherwise specified, the slump shall be:

(31-2)

<u>Type of Structure</u>	<u>Slump (inches)</u>
Massive sections, pavements, footings	2 $\pm$ 1/2
Heavy beams, thick slabs, thick walls (over 12 in.)	3 $\pm$ 1/2
Columns, light beams, thin slabs, thin walls (12 in. or less)	4 $\pm$ 1

##### 5. DESIGN OF THE CONCRETE MIX

###### (Option 1)(For use with Option 1 in Section 3.)

The Contractor will be responsible for the design of the concrete mixtures. At least 5 days prior to any placement of concrete he shall furnish the Contracting Officer a statement of the materials and mix proportions (including admixtures, if any) he intends to use for each specified class of concrete. The statement shall include evidence satisfactory to the Engineer that the materials and proportions selected will produce concrete of the quality, consistency and strength specified. The materials and proportions so stated shall constitute the "job mix." After a job mix has been designated, neither the source, character or grading of the aggregates nor the type or brand of cement or admixture shall be changed without prior notice to the Engineer.

When specified, a water-reducing, set-retarding admixture shall be used. When conditions are such that the temperature of the concrete at the time of placement is consistently above 75°F, a water-reducing, set-retarding admixture may be used, at the option of the Contractor. The cement content shall be same as that required in the mix without the admixture.

The use of calcium chloride or other accelerators or antifreeze compounds will not be allowed.

Before placing concrete containing a water-reducing, set-retarding admixture, the Contractor shall furnish test results to the Engineer showing that its performance in the job mix meets the requirements of Material Specification 533, Section 4.

###### (Option 2)(For use with Option 2 in Section 3.)

At least 35 days prior to any placement of concrete the Contractor shall inform the Contracting Officer in writing of the source and grading of aggregates and the brand and type of cement and the brand and type of admixture, if any, he proposes to use for each class of concrete, and shall furnish certifications or other

evidence satisfactory to the Engineer that the proposed materials meet the requirements of the specifications.

When acceptable sources, types and gradings of aggregates are designated in the contract, certifications for such aggregates will not be required.

Job mix proportions and batch weights will be determined by the Engineer. During the course of the work, the Engineer will adjust the job mix proportions and batch weights whenever necessary.

After the job mix has been designated, neither the source, character or grading of the aggregates nor the type or brand of cement or admixture shall be changed without prior notice to the Engineer.

If such changes are necessary, no concrete containing such new or altered materials shall be placed until the Engineer has designated a revised job mix.

When specified, a water reducing, set-retarding admixture shall be used. When conditions are such that the temperature of the concrete at the time of placement is consistently above 75°F, a water-reducing, set-retarding admixture may be used, at the option of the Contractor. The cement content shall be same as that required in the mix without the admixture.

The use of calcium chloride or other accelerators or antifreeze compounds will not be allowed.

When it is anticipated that a water-reducing, set-retarding admixture will be used, the Contractor shall furnish to the Engineer a sample of the admixture he proposes to use sufficient for the tests required by Material Specification 533, Section 4. Concrete containing the admixture shall not be placed until test results have been obtained showing that its performance in the job mix meets the requirements of Material Specification 533, Section 4.

## 6. INSPECTING AND TESTING

The following tests will be performed by the methods indicated:

<u>Test</u>	<u>Method</u> <u>(ASTM Designation)</u>
Sampling	C 172 <sup>1</sup>
Slump Test	C 143 <sup>1</sup>

(31-4)

<u>Test</u>	<u>Method</u> <u>(ASTM Designation)</u>
Air Content	C 231 <sup>1</sup> or C 173 <sup>1</sup>
Compression Test Specimens	C 31 <sup>1</sup> or C 42
Compressive Strength	C 39 <sup>2</sup> or C 42
Unit Weight	C 138

<sup>1</sup>Tests of a portion of a batch may be made on samples representative of that portion for any of the following purposes:

- (1) Determining uniformity of the batch.
- (2) Checking compliance with requirements for slump and air content when the batch is discharged over an extended period of time.
- (3) Checking compliance of the concrete with the specifications when the whole amount being placed in a small structure, or a distinct portion of a larger structure, is less than full batch.

<sup>2</sup>For each strength test of specimens made according to ASTM Designation C 31, 3 standard test specimens shall be made. The test result shall be the average of the strengths of the 3 specimens, except that if one specimen in the test shows manifest evidence of improper sampling, molding or testing, it shall be discarded and the strengths of the remaining 2 specimens shall be averaged. Should more than one specimen representing a test show such defects, the entire test shall be discarded.

(31-4a)





The Engineer shall have free entry to the plant and equipment furnishing concrete under the contract. Proper facilities shall be provided for the Engineer to inspect materials, equipment and processes and to obtain samples of the concrete. All tests and inspections will be conducted so as not to interfere unnecessarily with the manufacture and delivery of the concrete.

7. HANDLING AND MEASUREMENT OF MATERIALS

Aggregates shall be stored or stockpiled in such a manner that separation of coarse and fine particles of each size will be avoided and that various sizes will not become intermixed before proportioning. Methods of handling and transporting aggregates shall be such as to avoid contamination, excessive breakage, segregation or degradation, or intermingling of various sizes.

Scales for weighing aggregates and cement shall be beam type or springless dial type. They shall be accurate within 1 percent under operating conditions. All exposed fulcrums, clevises and similar working parts of scales shall be kept clean.

The quantities of cement and aggregates in each batch of concrete, as indicated by the scales, shall be within the following percentages of the required batch weights:

Cement - plus or minus 1.0 percent

Aggregates - plus or minus 2.0 percent

Measuring tanks for mixing water shall be of adequate capacity to furnish the maximum amount of mixing water required per batch and shall be equipped with outside taps and valves to provide for checking their calibration unless other means are provided for readily and accurately determining the amount of water in the tank.

Cement shall be measured by weight or in bags of 94 lbs. each. When cement is measured by weight, it shall be weighed on a scale separate from that used for other materials, and in a hopper entirely free and independent of the hopper used for weighing the aggregates. When cement is measured in bags, no fraction of a bag shall be used unless weighed.

Aggregates shall be measured by weight. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be the required saturated, surface-dry weight plus the weight of surface moisture it contains.

(31-5)

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Mixing water shall consist of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates and water introduced in the form of admixtures. The added water shall be measured by weight or volume to an accuracy of 1 percent of the required total mixing water. Added ice shall be measured by weight. Wash water shall not be used as a portion of the mixing water for succeeding batches.

Dry admixtures shall be measured by weight, and paste or liquid admixtures by weight or volume, within a limit of accuracy of 3 percent.

## 8. MIXERS AND MIXING

Concrete may be furnished by batch mixing at the site of the work or by ready-mix methods.

Mixers shall be capable of thoroughly mixing the concrete ingredients into a uniform mass within the specified mixing time and of discharging the mix without segregation. Each mixer or agitator shall bear a manufacturer's rating plate indicating the rated capacity and recommended speeds of rotation, and shall be operated in accordance with these recommendations.

Concrete shall be uniform and thoroughly mixed when delivered to the work. Variations in slump of more than 1 inch within a batch will be considered evidence of inadequate mixing and shall be corrected by changing batching procedures, increasing mixing time, changing mixers or other means. Mixing time shall be within the limits specified below unless the Contractor demonstrates by mixer performance tests that adequate uniformity is obtained by different times of mixing. For this purpose the testing program and uniformity requirements shall be as set forth in ASTM Designation C 94.

No mixing water in excess of the amount called for by the job mix shall be added to the concrete during mixing or hauling or after arrival at the delivery point.

Batch mixing at the site. For concrete mixed at the site of the work with paving mixers or stationary construction mixers, the time of mixing after all cement and aggregates are in the mixer drum shall be not less than 1½ minutes.

The batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates and all

(31-6)

mixing water shall be introduced into the drum before one-fourth of the mixing time has elapsed.

Controls shall be provided to insure that the batch cannot be discharged until the required mixing time has elapsed.

If truck mixers are used, the requirements below for truck mixers and truck-mixed concrete shall apply.

Ready-mixed concrete. Ready-mixed concrete shall be mixed and delivered to the site of the work by one of the following methods:

- a. Truck-mixed concrete--Mixed completely in a truck mixer.
- b. Shrink-mixed concrete--Mixed partially in a stationary mixer, and the mixing completed in a truck mixer.
- c. Central-mixed concrete--Mixed completely in a stationary mixer and the mixed concrete transported to the point of delivery in a truck agitator or in a truck mixer operating at agitating speed or in nonagitating equipment.

Truck mixers and agitators shall be equipped with revolution counters by which the number of revolutions of the drum or blades may be readily verified.

When ready-mixed concrete is furnished, the Contractor shall furnish the Engineer a statement-of-delivery ticket showing the time of loading, the revolution counter reading at the time of loading and the quantities of materials used for each load of concrete.

Truck-mixed concrete. When concrete is mixed in a truck mixer loaded to its maximum capacity, the number of revolutions of the drum or blades at mixing speed shall be not less than 70 nor more than 100. If the batch is at least 1/2 cubic yard less than maximum capacity, the number of revolutions at mixing speed may be reduced to not less than 50. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed. The mixing operation shall begin within 30 minutes after the cement has been added to the aggregates and the water shall be added during mixing. When

(31-7)



mixing is begun during or immediately after charging, a portion of the mixing water shall be added ahead of, or with, the other ingredients.

Shrink-mixed concrete. When concrete is partially mixed at a central plant and the mixing is completed in a truck mixer, the mixing time in the central plant mixer shall be the minimum required to intermingle the ingredients and shall be not less than 30 seconds. The mixing shall be completed in a truck mixer and the number of revolutions of the drum or blades at mixing speed shall be not less than 50 nor more than 100. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed.

Central-mixed concrete. For central-mixed concrete, mixing in the stationary mixer shall meet the same requirements as batching mixing at the site.

When an agitator, or truck mixer used as an agitator, transports concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed.

The use of nonagitating equipment to transport concrete to the site of the work will be permitted only if the consistency and uniformity of the concrete as discharged at the point of delivery meet the requirements of this specification. Bodies of nonagitating hauling equipment shall be so constructed that leakage of the concrete mix, or any part thereof, will not occur. Concrete hauled in open-top vehicles shall be protected against access of rain, and against exposure to the sun of more than 20 minutes when the air temperature is above 75°F.

## 9. FORMS

Forms shall be of wood, plywood, steel or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete will conform to the specified dimensions and contours. Form surfaces shall be smooth and free from holes, dents, sags or other irregularities. Forms shall be coated with a nonstaining form oil before being set into place.

(31-8)

Metal ties or anchorages within the forms shall be equipped with cones, she-bolts or other devices that permit their removal to a depth of at least one inch without injury to the concrete. Ties designed to break off below the surface of the concrete shall not be used without cones.

All edges that will be exposed to view when the structure is completed shall be chamfered, unless finished with molding tools as specified in Section 20.

#### 10. PREPARATION OF FORMS AND SUBGRADE

Prior to placement of concrete the forms and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any oil on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed. Rock surfaces shall be cleaned by air-water cutting, wet sandblasting or wire brush scrubbing, as necessary, and shall be wetted immediately prior to placement of concrete. Earth surfaces shall be firm and damp. Placement of concrete on mud, dried earth, uncompacted fill or frozen subgrade will not be permitted.

Unless otherwise specified, when concrete is to be placed over drain fill, the contact surface of the drain fill shall be covered with a layer of asphalt-impregnated building paper or polyvinyl sheeting prior to placement of the concrete. Forms for weepholes shall extend through this layer into the drain fill.

Items to be embedded in the concrete shall be positioned accurately and anchored firmly.

Weepholes in walls or slabs shall be formed with nonferrous materials.

#### 11. CONVEYING

Concrete shall be delivered to the site and discharged into the forms within 1½ hours after the introduction of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85°F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes. The Engineer may allow a longer time, provided the setting time of the concrete is increased a corresponding amount by the addition of an approved set-retarding admixture. In any case, concrete shall be conveyed from the mixer to the forms as rapidly as practicable, by methods that will prevent segregation of the aggregates or loss of mortar. Concrete shall not be dropped more than 5 feet vertically unless suitable equipment is used to prevent segregation.

#### 12. PLACING

Concrete shall not be placed until the subgrade, forms and steel reinforcement have been inspected and approved.

The Contractor shall have all equipment and materials required for curing available at the site ready for use before placement of concrete begins.

No concrete shall be placed except in the presence of the Engineer. The Contractor shall give reasonable notice to the Engineer each time he intends to place concrete. Such notice shall be far enough in advance to give the Engineer adequate time to inspect the subgrade, forms, steel reinforcement and other preparations for compliance with the specifications before concrete is delivered for placing.

The concrete shall be deposited as closely as possible to its final position in the forms and shall be worked into the corners and angles of the forms and around all reinforcement and embedded items in a manner to prevent segregation of aggregates or excessive laitance. The depositing of concrete shall be regulated so that the concrete may be consolidated with a minimum of lateral movement.

Internal stays and braces, serving temporarily to hold the forms in correct shape and alignment prior to placement of concrete at their locations, shall be removed when the concrete has been placed to an elevation such as to render their service unnecessary.

### 3. LAYERS

Unless otherwise specified, slab concrete shall be placed to design thickness in one continuous layer. Formed concrete shall be placed in horizontal layers not more than 20 inches thick. Hoppers and chutes, pipes or "elephant trunks" shall be used as necessary to prevent splashing of mortar on the forms and reinforcing steel above the layer being placed.

Successive layers shall be placed at a fast enough rate to prevent the formation of "cold joints." If the surface of a layer of concrete in place sets to the degree that it will not flow and merge with the succeeding layer when vibrated, the Contractor shall discontinue placing concrete and shall make a construction joint according to the procedure specified in Section 15.

If placing is discontinued when an incomplete layer is in place, the unfinished end of the layer shall be formed by a vertical bulkhead.

(31-10)

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#### 14. CONSOLIDATING

Unless otherwise specified, concrete shall be consolidated with internal type mechanical vibrators capable of transmitting vibration to the concrete at frequencies not less than 6000 impulses per minute.

The location, manner and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate, and without causing water or cement paste to flush to the surface.

The Contractor shall provide a sufficient number of vibrators to properly consolidate the concrete immediately after it is placed in the work. Vibration shall be applied in the freshly deposited concrete by slowly inserting and removing the vibrator at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective. The vibrator shall extend into the previously placed layer of fresh concrete, at all points, to insure effective bond between layers.

Vibration shall not be applied directly to the reinforcement steel or the forms nor to concrete that has hardened to the degree that it does not become plastic when vibrated.

The use of vibrators to transport concrete in the forms or conveying equipment will not be permitted.

Vibration shall be supplemented by spading and hand tamping as necessary to insure smooth and dense concrete along form surfaces, in corners and around embedded items.

#### 15. CONSTRUCTION JOINTS

Construction joints shall be made at the locations shown on the drawings. If construction joints are needed which are not shown on the drawings, they shall be placed in locations approved by the Engineer.

Where a feather edge would be produced at a construction joint, as in the top surface of a sloping wall, an insert form shall be used so that the resulting edge thickness on either side of the joint is not less than 6 inches.

(31-11)



In walls and columns as each lift is completed, the top surfaces shall be immediately and carefully protected from any condition that might adversely affect the hardening of the concrete.

Steel tying and form construction adjacent to concrete in place shall not be started until the concrete has cured at least 12 hours. Before new concrete is deposited on or against concrete that has hardened, the forms shall be retightened. New concrete shall not be placed until the hardened concrete has cured at least 12 hours.

(Option 1)

Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings, stains or debris by either wet sandblasting after the concrete has gained sufficient strength to resist excessive cutting, or air-water cutting as soon as the concrete has hardened sufficiently to prevent the jet from displacing the coarse aggregates, or both. The surface of the concrete in place shall be cut to expose clean, sound aggregate but not so deep as to undercut the edges of larger particles of the aggregate. After cutting, the surface shall be thoroughly washed to remove all loose material. If the surface is congested by reinforcing steel, is relatively inaccessible, or it is considered undesirable to disturb the concrete before it is hardened, cleaning of the joint by air-water jets will not be permitted and the wet sandblasting method will be required after the concrete has hardened.

(Option 2)

Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings, stains, or debris by washing and scrubbing with a wire brush or wire broom or by other means approved by the Engineer.

(Use with Either Option)

The surfaces shall be kept moist for at least one hour prior to placement of new concrete. The new concrete shall be placed directly on the cleaned and washed surface.

16. EXPANSION AND CONTRACTION JOINTS

Expansion and contraction joints shall be made only at locations shown on the drawings.

(31-12)

Exposed concrete edges at expansion and contraction joints shall be carefully tooled or chamfered, and the joints shall be free of mortar and concrete. Joint filler shall be left exposed for its full length with clean and true edges.

When open joints or weakened plane "dummy" joints are specified, the joints shall be constructed by the insertion and subsequent removal of a wood strip, metal plate or other suitable template in such a manner that the corners of the concrete will not be chipped or broken. The edges of the concrete at the joints shall be finished with an edging tool prior to removal of the joint strips.

Preformed expansion joint filler shall be held firmly in the correct position as the concrete is placed.

#### 17. WATERSTOPS

Waterstops shall be held firmly in the correct position as the concrete is placed. Joints in metal waterstops shall be brazed or welded. Joints in rubber or plastic waterstops shall be cemented, welded or vulcanized as recommended by the manufacturer.

#### 18. REMOVAL OF FORMS

Forms shall be removed only when the Engineer is present and shall not be removed without his approval. Forms shall be removed in such a way as to prevent damage to the concrete. Supports shall be removed in a manner that will permit the concrete to take the stresses due to its own weight uniformly and gradually.

##### (Option 1)

Forms shall not be removed sooner than the following minimum times after the concrete is placed. These periods represent cumulative number of days and fractions of days, not necessarily consecutive, during which the temperature of the air adjacent to the concrete is above 50°F.

<u>Element</u>	<u>Time</u>
Beams, arches - supporting forms and shoring	14 days
Conduits, deck slabs - supporting (inside) forms and shoring	7 days
Conduits (outside forms), sides of beams, small structures	24 hours
Columns, walls, spillway risers - with side or vertical load	7 days
Columns, walls, spillway risers - with no side or vertical load:	
Concrete supporting more than 30 feet of wall in place above it	7 days

(31-13)

<u>Element</u>	<u>Time</u>
Concrete supporting 20 to 30 feet of wall in place above it <sup>1</sup>	3 days
Concrete supporting not more than 20 feet in place about it <sup>1</sup>	24 hours

<sup>1</sup>Age of stripped concrete shall be at least 7 days before any load other than the weight of the column or wall itself is applied.

(Option 2)

Forms, supports and housings shall not be removed until the concrete has attained the strength specified in Section 26 for this purpose. The strength will be determined by compression testing of test cylinders cast by the Engineer for this purpose and cured at the work site in the manner specified in ASTM Method C 31 for determining form removal time.

19. FINISHING FORMED SURFACES

All concrete surfaces shall be true and even, and shall be free from open or rough spaces, depressions or projections.

Immediately after the removal of forms:

All bulges, fins, form marks or other irregularities which in the judgment of the Engineer will adversely affect the appearance or function of the structure shall be removed. All form bolts and ties shall be removed to a depth at least 1 inch below the surface of the concrete. The cavities produced by form ties and all other holes of similar size and depth shall be thoroughly cleaned and, after the interior surfaces have been kept continuously wet for at least 3 hours, shall be carefully packed with a dry patching mortar (preshrunk) mixed not richer than 1 part cement to 3 parts sand.

Holes left by form bolts or straps which pass through the wall shall be filled solid with mortar.

Patching mortar shall be thoroughly compacted into place to form a dense, well-bonded unit, and the in-place mortar shall be sound and free from shrinkage cracks.

All patched areas shall be cured as specified in Section 21.

20. FINISHING UNFORMED SURFACES

All exposed surfaces of the concrete shall be accurately screeded to grade and then float finished, unless specified otherwise.

(31-14)

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Excessive floating or troweling while the concrete is soft will not be permitted.

The addition of dry cement or water to the surface of the screeded concrete to expedite finishing will not be allowed.

Joints and edges on unformed surfaces that will be exposed to view shall be chamfered or finished with molding tools.

## 21. CURING

Concrete shall be prevented from drying for a curing period of at least 7 days after it is placed. Exposed surfaces shall be kept continuously moist for the entire period or until curing compound is applied as specified below. Moisture shall be maintained by sprinkling, flooding or fog spraying, or by covering with continuously moistened canvas, cloth mats, straw, sand or other approved material. Wood forms (except plywood) left in place during the curing period shall be kept wet. Formed surfaces shall be thoroughly wetted immediately after forms are removed and shall be kept wet until patching and repairs are completed. Water or covering shall be applied in such a way that the concrete surface is not eroded or otherwise damaged.

Water for curing shall be clean and free from any substances that will cause discoloration of the concrete.

Except as otherwise specified in Section 24, and except for construction joint surfaces, concrete may be coated with curing compound in lieu of the continued application of moisture.

The compound shall be sprayed on the moist concrete surfaces as soon as free water has disappeared, but shall not be applied to any surface until patching, repairs and finishing of that surface are completed.

The curing compound shall be thoroughly mixed immediately before applying, and shall be applied at a uniform rate of not less than one gallon per 150 square feet of surface. It shall form a uniform, continuous, adherent film that shall not check, crack or peel, and shall be free from pin holes or other imperfections.

Curing compound shall not be applied to surfaces requiring bond with subsequently placed concrete, such as construction joints, shear plates, reinforcing steel and other embedded items.

(31-15)



Surfaces subjected to heavy rainfall or running water within 3 hours after the compound has been applied, or surfaces damaged by subsequent construction operations during the curing period shall be resprayed in the same manner as for the original application.

## 22. REMOVAL OR REPAIR

When concrete is honeycombed, damaged or otherwise defective, the Contractor shall remove and replace the structure or structural member containing the defective concrete, or correct or repair the defective parts. The Engineer will determine the required extent of removal, replacement or repair.

Prior to starting repair work the Contractor shall obtain the Engineer's approval of his plan for making the repair. Such approval shall not be considered a waiver of the Contracting Officer's right to require complete removal of defective work if the completed repair does not produce concrete of the required quality and appearance.

Repair work shall be performed only when the Engineer is present.

Repair of formed surfaces shall be started within 24 hours after removal of the forms.

Except as otherwise approved by the Engineer, the appropriate methods described in Chapter VII of the Concrete Manual, Bureau of Reclamation, U. S. Department of the Interior, shall be used. If approved in writing by the Contracting Officer, proprietary compounds for adhesion or as patching ingredients may be used. Such compounds shall be used in accordance with the manufacturer's recommendations.

Curing as specified in Section 21 shall be applied to repaired areas immediately after the repairs are completed.

## 23. CONCRETING IN COLD WEATHER

When the atmospheric temperature may be expected to drop below 40°F at the time concrete is delivered to the work site, during placement, or at any time during the curing period, the following provisions also shall apply:

- a. The temperature of the concrete at time of placing shall not be less than 50°F nor more than 90°F. The temperature of neither aggregates nor mixing water shall be more than 100°F just prior to mixing with the cement.

(31-16)

- b. When the daily minimum temperature is less than 40°F, concrete structures shall be insulated or housed and heated after placement. The temperature of the concrete and air adjacent to the concrete shall be maintained at not less than 50°F nor more than 90°F for the duration of the curing period.
- c. Methods of insulating, housing and heating the structure shall conform to "Recommended Practice for Cold Weather Concreting," ACI Standard 306.
- d. When dry heat is used to protect concrete, means of maintaining an ambient humidity of at least 40 percent shall be provided unless the concrete has been coated with curing compound as specified in Section 21 or is covered tightly with an approved impervious material.

24. CONCRETING IN HOT WEATHER

When climatic or other conditions are such that the temperature of the concrete may reasonably be expected to exceed 90°F at the time of delivery at the work site, during placement, or during the first 24 hours after placement, the following provisions also shall apply;

- a. The Contractor shall maintain the temperature of the concrete below 90°F during mixing, conveying, and placing. Methods used shall conform to "Recommended Practice for Hot Weather Concreting," ACI Standard 605.
- b. The concrete shall be placed in the work immediately after mixing. Truck mixing shall be delayed until only time enough remains to accomplish it before the concrete is placed.
- c. Exposed concrete surfaces which tend to dry or set too rapidly shall be continuously moistened by means of fog sprays or otherwise protected from drying during the time between placement and finishing, and after finishing.
- d. Finishing of slabs and other exposed surfaces shall be started as soon as the condition of the concrete allows and shall be completed without delay.

(31-17)

- e. Concrete surfaces exposed to the air shall be covered as soon as the concrete has hardened sufficiently and shall be kept continuously wet for at least the first 24 hours of the curing period, and for the entire curing period unless curing compound is applied as specified in subsection g, below.
- f. Formed surfaces shall be kept completely and continuously wet for the duration of curing period (prior to, during and after form removal) or until curing compound is applied as specified in subsection g, below.
- g. If moist curing is discontinued before the end of the curing period, white pigmented curing compound shall be applied immediately, following the procedures specified in Section 21.

25. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, concrete will be measured to the neat lines or pay limits shown on the drawings, and the volume of concrete will be computed to the nearest 0.1 cubic yard. No deduction in volume will be made for chamfers, rounded or beveled edges, or for any void or embedded item that is less than five cubic feet in volume. Where concrete is placed against the sides or bottom of an excavation without intervening forms, drain fill, or bedding, the volume of concrete required to fill voids resulting from overexcavation outside the neat lines or pay limits will be included in the measurement for payment where such overexcavation is directed by the Engineer to remove unsuitable foundation material; but only to the extent that the unsuitable condition is not a result of the Contractor's operations.

(Option 1)

Payment for each item of concrete will be made at the contract unit price for that item. The payment for concrete will constitute full compensation for all labor, materials, equipment, transportation, tools, forms, falsework, bracing and all other items necessary and incidental to completion of the concrete work, such as joint fillers, waterstops, dowels or dowel assemblies and shear plates, but not including reinforcing steel or other items listed for payment elsewhere in the contract.

Measurement and payment for furnishing and placing reinforcing steel will be made as specified in Construction Specification 34.

(31-18)

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(Option 2)

Payment for each item of concrete will be made at the contract unit price for that item. The payment for concrete will constitute full compensation for all labor, materials, equipment, transportation, tools, forms, falsework, bracing and all other items necessary and incidental to completion of the concrete work, such as joint fillers, waterstops, dowels or dowel assemblies, and shear plates, but not including furnishing and placing reinforcing steel or furnishing and handling cement or other items listed for payment elsewhere in the contract.

Measurement and payment for furnishing and placing reinforcing steel will be made as specified in Construction Specification 34.

Cement will be measured by dividing the volume of concrete accepted for payment by the yield of the applicable job mix. The yield will be determined by the procedure specified in ASTM Designation C 138. If the amount of cement actually used per batch exceeds the amount in the job mix specified by the Engineer, the measurement will be based on the latter. One barrel of cement will be considered equal to 4 bags or 376 pounds. Payment for each type of cement will be made at the contract unit price for furnishing and handling that type of cement and such payment will constitute full compensation for all materials, labor, equipment, storage, transportation and all other items necessary and incidental to furnishing and handling the cement.

(Use with Either Option)

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 26 of this specification.





INSTRUCTIONS FOR THE USE OF CONSTRUCTION SPECIFICATION 32  
CONCRETE FOR MINOR STRUCTURES

1. Applicability

Construction Specification 32 is applicable to minor concrete structures such as inlets for pipe drops, pipe drainage inlets, bases for CMP risers, pipe supports, thrust blocks, small water control structures and similar structures, in which the quantity of concrete is less than 5 cubic yards per structure, and where the location of the concrete will allow economical maintenance or replacement.

2. Material Specifications

Material Specifications 531, 522, 535, 537 and 538 are complementary to Construction Specification 32. When local aggregates do not conform to the requirements of Material Specification 522 but are known to produce concrete of adequate quality, reference to Interim Standard Material Specifications is permissible, or requirements may be stated in the construction details.

3. Items to be Included in Contract Specifications and Drawings

- a. Complete engineering and structural detail drawings of the structure. (See Section 6, National Engineering Handbook.)
- b. Type, size and quality of joint filler, waterstops and shear plates, if applicable.
- c. Type of cement.
- d. Nominal size of coarse aggregate; or specifications for aggregate if Material Specification 522 does not apply.
- e. Types of admixtures, if any.
- f. Special slump and air content requirements, if applicable.
- g. Special note if a membrane is not required under concrete to be placed on drain fill.

4. Discussion of Options

No options are included. However, the payment clause in Section 23 is written to permit either unit price or lump sum payment.

THE UNIVERSITY OF CHICAGO

PHYSICS DEPARTMENT

PHYSICS 354

LECTURE 1

LECTURE 2

LECTURE 3

CONSTRUCTION SPECIFICATION (GUIDE)32. CONCRETE FOR MINOR STRUCTURES1. SCOPE

The work shall consist of furnishing, forming, placing, finishing and curing portland cement concrete as required to build the structures named in Section 24 of this specification.

2. MATERIALS

Portland cement shall conform to the requirements of Material Specification 531 for the specified type.

Aggregates shall conform to the requirements of Material Specification 522 unless otherwise specified. The grading of coarse aggregates shall be as specified in Section 24.

Water shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter or other deleterious substances.

Preformed expansion joint filler shall conform to the requirements of Material Specification 535.

Waterstops shall conform to the requirements of Material Specifications 537 and 538 for the specified kinds.

3. CLASS OF CONCRETE

Concrete for minor structures shall be classified as follows:

<u>Class of Concrete</u>	<u>Maximum Net Water Content (gallons/bag)</u>	<u>Minimum Cement Content (bags/cu. yd.)</u>
3000M	7	6

4. AIR CONTENT AND CONSISTENCY

Unless otherwise specified, the slump shall be 2 to 4 inches. If air entrainment is specified, the air content by volume shall be 5 to 8 percent of the volume of the concrete. When specified or when directed by the Engineer, a water-reducing, set-retarding admixture approved by the Engineer shall be used.

(32-1)



5. DESIGN OF THE CONCRETE MIX

The proportions of the aggregates shall be such as to produce a concrete mixture that will work readily into the corners and angles of the forms and around reinforcement when consolidated, but will not segregate or exude free water during consolidation.

Prior to placement of concrete, the Contractor shall furnish the Engineer, for approval, a statement of the materials and mix proportions (including admixtures, if any) he intends to use. The statement shall include evidence satisfactory to the Engineer that the materials and proportions will produce concrete conforming to this specification. The materials and proportions so stated shall constitute the "job mix." After a job mix has been approved, neither the source, character or grading of the aggregates nor the type or brand of cement or admixture shall be changed without prior notice to the Engineer. If such changes are necessary, no concrete containing such new or altered materials shall be placed until the Engineer has approved a revised job mix.

6. INSPECTION AND TESTING

The Engineer shall have free entry to the plant and equipment furnishing concrete under the contract. Proper facilities shall be provided for the Engineer to inspect materials, equipment and processes and to obtain samples of the concrete. All tests and inspections will be conducted so as not to interfere unnecessarily with manufacture and delivery of the concrete.

7. HANDLING AND MEASUREMENT OF MATERIALS

Materials shall be stockpiled and batched by methods that will prevent segregation or contamination of aggregates and insure accurate proportioning of the ingredients of the mix.

Cement shall be measured by weight or in bags of 94 pounds each. When cement is measured in bags, no fraction of a bag shall be used unless weighed.

Aggregates shall be measured by weight. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be the required saturated, surface-dry weight plus the weight of surface moisture it contains.

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Water shall be measured, by volume or by weight, to an accuracy within one percent of the total quantity of water required for the batch.

Admixtures shall be measured within a limit of accuracy of three percent.

#### 8. MIXERS AND MIXING

Concrete shall be uniform and thoroughly mixed when delivered to the work. Variations in slump of more than 1 inch within a batch will be considered evidence of inadequate mixing and shall be corrected by increasing mixing time or other means.

For stationary mixers, the mixing time after all cement and aggregates are in the mixer drum shall be not less than  $1\frac{1}{2}$  minutes. When concrete is mixed in a truck mixer, the number of revolutions of the drum or blades at mixing speed shall be not less than 70 nor more than 100.

No mixing water in excess of the amount called for by the job mix shall be added to the concrete during mixing or hauling or after arrival at the delivery point.

#### 9. FORMS

Forms shall be of wood, plywood, steel or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete will conform to the specified dimensions and contours. Form surfaces shall be smooth and free from holes, dents, sags or other irregularities. Forms shall be coated with a nonstaining form oil before being set into place.

Metal ties or anchorages within the forms shall be equipped with cones, she-bolts or other devices that permit their removal to a depth of at least one inch without injury to the concrete. Ties designed to break off below the surface of the concrete shall not be used without cones.

All edges that will be exposed to view when the structure is completed shall be chamfered, unless finished with molding tools as specified in Section 18.

#### 10. PREPARATION OF FORMS AND SUBGRADE

Prior to placement of concrete the forms and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any oil on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed. Rock surfaces shall be cleaned by

air-water cutting, wet sandblasting or wire brush scrubbing, as necessary, and shall be wetted immediately prior to placement of concrete. Earth surfaces shall be firm and damp. Placement of concrete on mud, dried earth or uncompacted fill or frozen subgrade will not be permitted.

Unless otherwise specified, when concrete is to be placed over drain fill, the contact surface of the drain fill shall be covered with a layer of asphalt-impregnated building paper or polyvinyl sheeting prior to placement of the concrete. Forms for weepholes shall extend through this layer into the drain fill.

Items to be embedded in the concrete shall be positioned accurately and anchored firmly.

Weepholes in walls or slabs shall be formed with nonferrous materials.

#### 11. CONVEYING

Concrete shall be delivered to the site and discharged into the forms within 1½ hours after the introduction of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes. The Engineer may allow a longer time, provided the setting time of the concrete is increased a corresponding amount by the addition of an approved set-retarding admixture. In any case, concrete shall be conveyed from the mixer to the forms as rapidly as practicable by methods that will prevent segregation of the aggregates or loss of mortar. Concrete shall not be dropped more than five feet vertically unless suitable equipment is used to prevent segregation.

#### 12. PLACING

Concrete shall not be placed until the subgrade, forms and steel reinforcement have been inspected and approved. No concrete shall be placed except in the presence of the Engineer. The Contractor shall give reasonable notice to the Engineer each time he intends to place concrete. Such notice shall be far enough in advance to give the Engineer adequate time to inspect the subgrade, forms, steel reinforcement and other preparations for compliance with the specifications before concrete is delivered for placing.

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The concrete shall be deposited as closely as possible to its final position in the forms and shall be worked into the corners and angles of the forms and around all reinforcement and embedded items in a manner to prevent segregation of aggregates or excessive laitance. Unless otherwise specified, slab concrete shall be placed to design thickness in one continuous layer. Formed concrete shall be placed in horizontal layers not more than 20 inches thick. Hoppers and chutes, pipes or "elephant trunks" shall be used as necessary to prevent splashing of mortar on the forms and reinforcing steel above the layer being placed.

Immediately after the concrete is placed in the forms, it shall be consolidated by spading, hand tamping or vibration as necessary to insure smooth surfaces and dense concrete. Each layer shall be consolidated to insure monolithic bond with the preceding layer. If the surface of a layer of concrete in place sets to the degree that it will not flow and merge with the succeeding layer when spaded or vibrated, the Contractor shall discontinue placing concrete and shall make a construction joint according to the procedure specified in Section 13.

If placing is discontinued when an incomplete horizontal layer is in place, the unfinished end of the layer shall be formed by a vertical bulkhead.

### 13. CONSTRUCTION JOINTS

Construction joints shall be made at the locations shown on the drawings. If construction joints are needed which are not shown on the drawings, they shall be placed in locations approved by the Engineer.

Where a feather edge would be produced at a construction joint, as in the top surface of a sloping wall, an insert form shall be used so that the resulting edge thickness on either side of the joint is not less than 6 inches.

In walls and columns, as each lift is completed, the top surfaces shall be immediately and carefully protected from any condition that might adversely affect the hardening of the concrete.

Steel tying and form construction adjacent to concrete in place shall not be started until the concrete has cured at least 12 hours. Before new concrete is deposited on or against concrete that has hardened, the forms shall be retightened. New concrete shall not be placed until the hardened concrete has cured at least 12 hours.



Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings or debris by washing and scrubbing with a wire brush or wire broom or by other means approved by the Engineer. The surfaces shall be kept moist for at least one hour prior to placement of the new concrete.

14. EXPANSION AND CONTRACTION JOINTS

Expansion and contraction joints shall be made only at locations shown on the drawings.

Exposed concrete edges at expansion and contraction joints shall be carefully tooled or chamfered, and the joints shall be free of mortar and concrete. Joint filler shall be left exposed for its full length with clean and true edges.

Preformed expansion joint filler shall be held firmly in the correct position as the concrete is placed.

When open joints are specified, they shall be constructed by the insertion and subsequent removal of a wooden strip, metal plate or other suitable template in such a manner that the corners of the concrete will not be chipped or broken. The edges of open joints shall be finished with an edging tool prior to removal of the joint strips.

15. WATERSTOPS

Waterstops shall be held firmly in the correct position as the concrete is placed. Joints in metal waterstops shall be soldered, brazed or welded. Joints in rubber or plastic waterstops shall be cemented, welded or vulcanized as recommended by the manufacturer.

16. REMOVAL OF FORMS

Forms shall not be removed without the approval of the Engineer. Forms shall be removed in such a way as to prevent damage to the concrete. Supports shall be removed in a manner that will permit the concrete to take the stresses due to its own weight uniformly and gradually.

17. FINISHING FORMED SURFACES

Immediately after the removal of the forms:

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- a. All fins and irregular projections shall be removed from exposed surfaces.
- b. On all surfaces, the holes produced by the removal of form ties, cone-bolts, and she-bolts shall be cleaned, wetted and filled with a dry-pack mortar consisting of one part portland cement, three parts sand that will pass a No. 16 sieve, and water just sufficient to produce a consistency such that the filling is at the point of becoming rubbery when the material is solidly packed.

#### 18. FINISHING UNFORMED SURFACES

All exposed surfaces of the concrete shall be accurately screeded to grade and then float finished, unless specified otherwise.

Excessive floating or troweling of surfaces while the concrete is soft will not be permitted.

The addition of dry cement or water to the surface of the screeded concrete to expedite finishing will not be allowed.

Joints and edges on unformed surfaces that will be exposed to view shall be chamfered or finished with molding tools.

#### 19. CURING

Concrete shall be prevented from drying for a curing period of at least 7 days after it is placed. Exposed surfaces shall be kept continuously moist for the entire period, or until curing compound is applied as specified below. Moisture shall be maintained by sprinkling, flooding or fog spraying or by covering with continuously moistened canvas, cloth mats, straw, sand or other approved material. Wood forms (except plywood) left in place during the curing period shall be kept wet. Formed surfaces shall be thoroughly wetted immediately after forms are removed and shall be kept wet until patching and repairs are completed. Water or covering shall be applied in such a way that the concrete surface is not eroded or otherwise damaged.

Concrete, except at construction joints, may be coated with an approved curing compound in lieu of continued application of moisture. The compound shall be sprayed on the moist concrete surfaces as soon as free water has disappeared, but shall not be applied to any surface until patching, repairs and finishing of that surface

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are completed. The compound shall be applied at a uniform rate of not less than one gallon per 150 square feet of surface and shall form a continuous adherent membrane over the entire surface. Curing compound shall not be applied to surfaces requiring bond to subsequently placed concrete, such as construction joints, shear plates, reinforcing steel and other embedded items. If the membrane is damaged during the curing period, the damaged area shall be resprayed at the rate of application specified above.

20. REMOVAL OR REPAIR

When concrete is honeycombed, damaged or otherwise defective, the Contractor shall remove and replace the structure or structural member containing the defective concrete or, where feasible, correct or repair the defective parts. The Engineer will determine the required extent of removal, replacement or repair. Prior to starting repair work the Contractor shall obtain the Engineer's approval of his plan for effecting the repair. The Contractor shall perform all repair work in the presence of the Engineer.

21. CONCRETING IN COLD WEATHER

Concrete shall not be mixed nor placed when the daily minimum atmospheric temperature is less than 40°F unless facilities are provided to prevent the concrete from freezing. The use of accelerators or antifreeze compounds will not be allowed.

22. CONCRETING IN HOT WEATHER

The Contractor shall apply effective means to maintain the temperature of the concrete below 90°F during mixing, conveying and placing.

23. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, concrete will be measured to the neat lines shown on the drawings and the volume of concrete will be computed to the nearest 0.1 cubic yard. Measurement of concrete placed against the sides of an excavation without the use of intervening forms will be made only to the neat lines or pay limits shown on the drawings. No deduction in volume will be made for chamfers, rounded or beveled edges or for any void or embedded item that is less than 3 cubic feet in volume.

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Payment for each item of concrete for minor structures will be made at the contract unit price or the contract lump sum, whichever is applicable, for that item. Such payment will constitute full compensation for all labor, materials, equipment, transportation, tools, forms, falsework, bracing and all other items necessary and incidental to the completion of the work, except items listed for payment elsewhere in the contract.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 24 of this specification.

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 33PNEUMATICALLY APPLIED MORTAR (PAM)1. Applicability.

Construction Specification 33 is applicable to the placement of pneumatically applied mortar.

2. Material Specifications.

The following specifications are complementary to Construction Specification 33:

a. Portland Cement.

Specification 531

b. Aggregates.

Specification 522

c. Curing Compounds.

Specification 534

3. Items to be Included in Contract Specifications and Drawings.

## a. Complete engineering drawings and structural detail drawings as specified in Section 6, National Engineering Handbook, including as a minimum:

(1) Plans and cross sections showing the surface dimensions and thickness of all PAM slabs, walls or layers and neat pay lines.

(2) Reinforcement details including bar placement diagrams, details of welded wire fabric reinforcement, cover requirements.

(3) Finish lines and grades.

(4) Joint and edge details.

## b. The nature of subgrade materials.

- c. Notes as necessary to indicate special placement or finishing requirements.
  - d. Type of cement.
  - e. Required compressive strength.
4. Discussion of Options.

Section 17, Measurement and Payment

Option 1 is intended for use where the mortar in place is to be of reasonably uniform shape and thickness so that measurement of the surface area will be feasible and will be representative of the amount of mortar placed.

Option 2 is intended for use where measurement of the mortar in place will not be feasible or when payment by materials used rather than mortar in place is desirable for other reasons.

Both options may be included as numbered methods in standard specifications. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

Both Methods. The following provisions apply to both methods of measurement and payment.

CONSTRUCTION SPECIFICATION (GUIDE)33. PNEUMATICALLY APPLIED MORTAR (PAM)1. SCOPE

The work shall consist of furnishing, mixing, applying and curing pneumatically applied mortar. Except as otherwise specified, a dry mix or wet mix process may be used.

2. MATERIALS

Portland cement shall conform to the requirements of Material Specification 531 for the specified type.

Aggregates shall conform to the requirements of Material Specification 522 unless otherwise specified.

Water used in mixing or curing pneumatically applied mortar shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter or other deleterious substances.

Curing compound shall conform to the requirements of Material Specification 534.

3. STRENGTH AND QUALITY

The compressive strength of pneumatically applied mortar at the age of 28 days shall be not less than specified in Section 18 of this specification.

Pneumatically applied mortar shall be uniform and dense, free from "drummy" areas, laminations, voids and sand pockets.

4. CONSISTENCY

The proportion of water added to the mixture shall be accurately controlled to produce thorough and uniform hydration of the mortar. The consistency of the mortar shall be such that the surface of the mortar in place shall have a rich, glossy appearance and that the mortar shall adhere to the supporting surface without flowing, slumping or sloughing. For application to vertical or overhanging surfaces the mix proportions shall be adjusted so that the placed mortar will adhere to a thickness of 3/4 inch without sagging or sloughing. For adjustment of consistency the addition of fly ash

(33-1)



or diatomaceous earth conforming to ASTM Specifications C 618 to the mixture in amounts not greater than 3 percent (by weight) of cement in the mixture will be permitted.

## 5. INSPECTION AND TESTING

The compressive strength of the mortar will be determined in accordance with ASTM Method C 42. The compression test specimens will be cores not less than 3 inches in nominal diameter taken from the test panels described below or from the structure.

Before pneumatically applied mortar is placed, test panels simulating actual job conditions shall be made by shooting the mortar against a back form of plywood or similar material. The panels shall be not less than 30 inches square and not less than 4 inches thick. They shall be made by the nozzleman who will be applying the mortar on the job, using the mix proportions, air and water pressures, and nozzle settings to be used for the job. A separate panel shall be made for each mix and for each shooting position to be encountered on the job. Not more than 3 representative shooting positions will be required: representing (1) horizontal surfaces, (2) vertical or sloping surfaces, and (3) overhead surfaces.

Similar panels not less than 12 inches square and not less than 4 inches thick shall be made periodically as directed by the Engineer during the progress of the work.

Test panels and cores will be handled and cured according to the requirements of ASTM Method C 31.

For each strength test, 3 cores will be tested in compression. The test result will be the average of the strengths of the 3 specimens, except that if one specimen shows manifest evidence of improper sampling, coring, or testing, it will be discarded and the strengths of the remaining 2 specimens will be averaged. If more than one specimen representing a test shows such defects, the entire test will be discarded.

The Contractor shall furnish the forms and make the required test panels and shall provide such facilities, materials and assistance as may be necessary for curing, handling, and protecting the panels. Test panels shall be cast only when the Engineer is present.

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## 6. MEASURING MATERIALS

The proportions of the mortar mix shall be controlled on the basis of the weight of each component material except that water may be measured by volume.

## 7. EQUIPMENT

The Contractor shall furnish all equipment necessary for batching, mixing and placing the mortar. Batching and mixing equipment shall include weighing equipment accurate to within 0.4 percent of scale capacity, a power driven mortar mixer capable of thoroughly mixing the materials at a rate adequate to insure uniform feeding of the mixture to the placing equipment, and a feeding apparatus capable of supplying the mixture to the placing equipment at an adequate and uniform rate.

The placing equipment for dry mix mortar shall be designed and equipped to receive the dry mix, introduce it into a stream of compressed air, convey it pneumatically through a delivery hose to a nozzle at the point of discharge, inject water under pressure into the suspended stream of dry sand and cement within the nozzle, and spray the resulting mortar mix onto the surface of the work at a uniform rate and at a controlled velocity. The placing equipment shall be equipped with accurate gages to indicate the air pressure and water pressure and with devices capable of accurately controlling the air pressure at any level between 35 p.s.i. and 80 p.s.i., the water pressure at any level between 50 p.s.i. and 100 p.s.i., and the rate of application of water at the nozzle.

The placing equipment for wet mix mortar shall be designed and equipped to receive the mortar from the mixer, convey it through a delivery hose to a nozzle at the point of discharge, accelerate it in the nozzle by means of compressed air, and spray it onto the surface of the work. It shall be capable of delivering mortar to the nozzle uniformly and continuously and discharging it from the nozzle at a uniform rate and at a controlled velocity sufficient for all parts of the work.

The length of the discharge hose shall not exceed 350 feet.

## 8. MIXING

For dry mix mortar, the cement and sand shall be mixed by at least 25 revolutions of the mixer drum before being fed into the placing equipment. The dry mix shall be used promptly after mixing and any material that is not placed within 45 minutes after mixing shall be wasted.

(33-3)

For wet mix mortar, the cement, sand, and water shall be thoroughly mixed in the mixer drum sufficiently to produce mortar of the required consistency which is uniform within each batch and uniform from batch to batch when discharged into the placing equipment.

The entire contents of the mixer shall be discharged from the drum before materials for a succeeding batch are placed therein.

9. FORMS

Forms shall be structurally adequate and of such design that rebound or accumulated loose sand can freely escape or be readily removed. Shooting strips shall be used at corners, edges, and on surfaces where necessary to obtain true lines and proper thickness. Where practicable, ground wires shall be installed as guides to accurately establish the specified contour of the finished surface of mortar. Ground wires shall be set and used as guides for templates in forming curved and molded surfaces. When pneumatically applied mortar is to be placed on horizontal or sloping surfaces, headers and ground wires shall be provided to the extent necessary to insure control of slab thickness. Ground wires shall be tightened and kept taut, secure, and true to line and plane during placement of mortar and shall be removed when placement of mortar is completed.

Header boards will be required where the drawings indicate a square edge and at required joints. Form surfaces shall be thoroughly cleaned and oiled before mortar is placed.

10. PREPARATION OF SURFACES TO RECEIVE PAM

All surfaces to receive or support pneumatically applied mortar shall be carefully prepared and conditioned. All such prepared surfaces shall be inspected and approved by the Engineer prior to the application of mortar.

Earth surfaces to which pneumatically applied mortar is to be applied shall be firmly compacted and neatly trimmed to line and grade.

Asphaltic concrete surfaces shall be thoroughly cleaned of any growths, earth, or any other material that would affect bond, or be detrimental to the pneumatically applied mortar.

Concrete, mortar, or rock surfaces shall be thoroughly cleaned to remove all dirt, laitance, weak or unbonded mortar, loose material, grease or other deleterious substances.

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Surfaces on which the pneumatically applied mortar is to be placed shall be sufficiently rough to insure the adherence of the mortar. Offsets which would cause an abrupt and substantial change in thickness of the mortar shall be removed or tapered.

All surfaces shall be maintained in a moistened condition for three hours before application of pneumatically applied mortar. Pneumatically applied mortar shall not be applied to mud, dried earth, uncompacted fill, or frozen surfaces, or to surfaces on which free water exists.

#### 11. PLACING

The Contractor shall have all equipment and materials required for curing available at the site and ready for use before placement of pneumatically applied mortar begins.

No mortar shall be placed except in the presence of the Engineer. The Contractor shall give reasonable notice to the Engineer each time he intends to place mortar. Such notice shall be far enough in advance to give the Engineer adequate time to inspect the surfaces to which the mortar is to be applied, the forms, steel reinforcement, and other preparations for compliance with the specifications before placement is begun.

During placement of the mortar the air pressure shall be adjusted as required to control rebound and density of mortar. For a given application, once the optimum operating pressures have been established they shall be maintained constant throughout the application. For dry mix mortar, the air pressure at the machine shall be not less than 35 p.s.i. plus 5 p.s.i. for each 50 feet of length of the discharge hose and the water pressure at the nozzle shall be not less than 15 p.s.i. greater than the air pressure at the machine.

The placing nozzle shall be held about 3 feet from and approximately normal to the surface of the work. Corners shall be filled first.

When coatings one inch or more in thickness are to be applied to vertical or overhanging surfaces, the pneumatically applied mortar shall be applied in two or more layers not more than 3/4 inch in thickness. On horizontal or slightly sloping surfaces the thickness of a single layer may vary from one inch to a maximum of 3-1/2 inches. When more than a single layer is applied, placement of subsequent layers shall be delayed long enough to prevent sloughing but shall be accomplished before the previously placed mortar has completely set. When pneumatically applied mortar is placed on a vertical surface, application shall be started at the bottom and be completed at the top.

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In any case when the placing of pneumatically applied mortar is interrupted for more than one hour, the edge of the layer shall be sloped off at an angle of approximately 45 degrees to the surface being shot, and the sloped portion shall be covered with a double layer of seven-ounce burlap and kept continuously moist until the application of mortar is resumed. Before applying new material, the sloped portion shall be thoroughly cleaned and wetted by means of an air and water blast or equally effective method approved by the Engineer.

Material that rebounds and accumulates on forms, subgrade surfaces or reinforcing steel ahead of the mortar being placed shall be removed.

In no case shall mortar be applied over rebound debris. Rebound debris shall not be reused in mortar on any portion of the work and shall be disposed of as the work progresses.

## 12. FINISHING

Rebound material shall be carefully swept off the finished mortar surface before it becomes too hard for removal.

Pneumatically applied mortar shall not be screeded. After the mortar has been placed to the depth required the surface shall be checked with a straightedge or template and any low spot shall be brought up to specified grade by placing additional pneumatically applied mortar. Finishing of mortar surfaces by means of floats or trowels will not be permitted.

## 13. CURING

Pneumatically applied mortar shall be prevented from drying for a curing period of at least 7 days after it is placed. Exposed surfaces shall be kept continuously moist for the entire period or until curing compound is applied as specified below. Moisture shall be maintained by sprinkling, flooding or fog spraying, or by covering with continuously moistened canvas, cloth mats, straw, sand or other approved material. Wood forms (except plywood) left in place during the curing period shall be kept wet. Formed surfaces shall be thoroughly wetted immediately after forms are removed and shall be kept wet until patching and repairs are completed. Water or covering shall be applied in such a way that the mortar surface is not eroded or otherwise damaged.

Water for curing shall be clean and free from any substances that will cause discoloration of the mortar where finished surfaces will be exposed to view.

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Except as otherwise specified in Section 16, and except for surfaces to which additional mortar is to be applied, pneumatically applied mortar may be coated with curing compound in lieu of the continued application of moisture.

The compound shall be sprayed on the moist mortar surfaces as soon as rebound has been removed and any required repairs are completed, or as soon as water curing is discontinued.

The curing compound shall be thoroughly mixed immediately before applying, and shall be applied at a uniform rate of not less than one gallon per 150 square feet of surface. It shall not check, crack or peel, and shall be free from pin holes or other imperfections.

Curing compound shall not be applied to subgrade surfaces or other surfaces requiring bond with subsequently placed mortar, such as construction joints, reinforcing steel and other embedded items.

Surfaces subjected to heavy rainfall or running water within 3 hours after the compound has been applied, or surfaces damaged by subsequent construction operations during the curing period shall be resprayed in the same manner as for the original applications.

#### 14. REPLACEMENT OR REPAIR

When pneumatically applied mortar has "drummy" areas, voids, sand pockets, or is damaged or otherwise defective, the Contractor shall remove and replace the portion of the structure containing the defective mortar, or correct or repair the defective parts. The Engineer will determine the required extent of removal, replacement or repair.

Prior to starting repair work the Contractor shall obtain the Engineer's approval of his plan for making the repair. Such approval shall not be considered a waiver of the Contracting Officer's right to require complete removal of defective work if the completed repair does not produce mortar of the required quality and appearance.

Repair work shall be performed only when the Engineer is present.

Repairs shall be made with pneumatically applied mortar conforming to this specification. When removal of defective mortar is required, reinforcement damaged or destroyed shall be replaced prior to replacement of the mortar. At the edges of removed sections the sound mortar shall be carefully trimmed to the extent required to expose sufficient reinforcement for effecting competent splices. The sound mortar at the edges of removed sections shall be trimmed to a slope of approximately 45 degrees with the surface of the work and shall be thoroughly moistened prior to placement of the new mortar.

Any portions of the work having thicknesses less than those specified may be repaired by the placement of additional layers of

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pneumatically applied mortar, provided that such repair is expressly authorized.

Surfaces of the work to which additional pneumatically applied mortar is to be applied shall be prepared as required by Section 10 of this specification.

Curing as specified in Section 13 shall be applied to repaired areas immediately after the repairs are completed.

#### 15. PLACING IN COLD WEATHER

When the atmospheric temperature may be expected to drop below 40°F at the time pneumatically applied mortar is placed, or at any time during the curing period, the following provisions also shall apply:

- a. The temperature of the mortar at time of placing shall not be less than 50°F nor more than 90°F. The temperature of neither aggregates nor mixing water shall be more than 100°F just prior to mixing with the cement.
- b. When the daily minimum temperature is less than 40°F, mortar shall be insulated or housed and heated after placement. The temperature of the mortar and air adjacent to the mortar shall be maintained at not less than 50°F nor more than 90°F for the duration of the curing period.
- c. Methods of insulating, housing and heating the structure shall conform to "Recommended Practice for Cold Weather Concreting," ACI Standard 306.
- d. The use of accelerators or antifreeze compounds will not be allowed.
- e. When dry heat is used to protect mortar, means of maintaining an ambient humidity of at least 40 percent shall be provided unless the mortar has been coated with curing compound as specified in Section 13 or is covered tightly with an approved impervious material.

#### 16. PLACING IN HOT WEATHER

When climatic or other conditions are such that the temperature of pneumatically applied mortar may reasonably be expected to exceed 90°F at the time of placement, or during the first 24 hours after placement, the following provisions also shall apply:

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- a. The Contractor shall maintain the temperature of the mortar below 90°F during mixing, conveying, and placing. Methods used shall conform to "Recommended Practice for Hot Weather Concreting," ACI Standard 605.
- b. Exposed mortar surfaces which tend to dry or set too rapidly shall be continuously moistened by means of fog sprays or otherwise protected from drying immediately after placement.
- c. Mortar surfaces exposed to the air shall be covered as soon as the mortar has hardened sufficiently and shall be kept continuously wet for at least the first 24 hours of the curing period, and for the entire curing period unless curing compound is applied as specified in subsection d, below.
- d. If moist curing is discontinued before the end of the curing period, white pigmented curing compound shall be applied immediately, following the procedures specified in Section 13.

#### 17. MEASUREMENT AND PAYMENT

(Option 1) For items of work for which specific unit prices are established in the contract, the dimensions of the **exposed** surface of the pneumatically applied mortar will be measured to the neat lines shown on the drawings and the surface area will be computed to the nearest square foot. Payment will be made at the contract unit price for pneumatically applied mortar. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the work, including making and handling test panels but not including reinforcing steel or other items listed for payment elsewhere in the contract.

Measurement and payment for furnishing and placing reinforcing steel will be made as specified in Construction Specification 34.

(Option 2) For items of work for which specific unit prices are established in the contract, cement and aggregates used in pneumatically applied mortar and in authorized test panels will be measured by the batch weights of the materials charged into the mixer. No deduction will be made for normal rebound; however, payment will not be made for material wasted because of mechanical failure or **improper** mixing or placing or because the in-place mortar does not conform to the specifications. Payment will be made at the contract unit prices for cement and aggregates for pneumatically applied mortar. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to completion of the work, including making and handling test panels but not including reinforcing steel or other items listed for payment elsewhere in the contract.



Measurement and payment for furnishing and placing reinforcing steel will be made as specified in Construction Specification 34.

(Use with Either Option) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 18 of this specification.

(33-10)

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 34STEEL REINFORCEMENT1. Applicability.

Construction Specification 34 is applicable to the placement of steel bar reinforcement and steel welded wire fabric reinforcement for reinforced concrete or pneumatically applied mortar.

2. Material Specifications.

The following specifications are complementary to Construction Specification 34:

a. Steel Reinforcement.

Specification 539

b. Galvanizing.

Specification 582

3. Items to be Included in Contract Specifications and Drawings.

- a. Complete placing drawings. (Detail drawings as specified in Section 6, National Engineering Handbook.)
- b. Steel schedule and bar list and bending diagram if needed to facilitate the placement drawings. These are usually needed for all except very simple structures.
- c. Type and grade of steel if it is necessary to restrict Contractor's choice from the list in Material Specification 539.

4. Discussion of Options.Section 8, Measurement and Payment.

- (1) Option 1 is intended for use when all reinforcement is measured by weight.
- (2) Option 2 is intended for use when bar reinforcement is measured by weight and welded wire fabric reinforcement is measured by area.

Both options may be included as numbered methods in standard specifications. If numbered methods are

used, insert the following paragraph before the last paragraph in the section:

Both Methods. The following provisions apply to both methods of measurement and payment.

CONSTRUCTION SPECIFICATION (GUIDE)34. STEEL REINFORCEMENT1. SCOPE

The work shall consist of furnishing and placing steel reinforcement for reinforced concrete or pneumatically applied mortar.

2. MATERIALS

Steel reinforcement shall conform to the requirements of Material Specification 539. Before reinforcement is placed the surfaces of the bars and fabric and any metal supports shall be cleaned to remove any loose, flaky rust, mill scale, oil, grease or other coatings or foreign substances. After placement the reinforcement shall be maintained in a clean condition until it is completely embedded in the concrete.

3. BAR SCHEDULE, LISTS AND DIAGRAMS

Any supplemental bar schedules, bar lists or bar-bending diagrams required to accomplish the fabrication and placement of reinforcement shall be provided by the Contractor. Prior to placement of reinforcement, the Contractor shall furnish three prints or copies of any such lists or diagrams to the Contracting Officer. Acceptance of the reinforcement will not be based on approval of these lists or diagrams but will be based on inspection of the reinforcement after it has been placed.

4. BENDING

Reinforcement shall be cut and bent in compliance with the requirements of the American Concrete Institute Standard 315. Bars shall not be bent or straightened in a manner that will injure the material. Bars with kinks, cracks or improper bends will be rejected.

5. SPLICING BAR REINFORCEMENT

Unless otherwise specified on the drawings, splices of reinforcing bars shall provide an overlap equal to at least 30 times the diameter of the smaller bar in the splice but not less than 12 inches.

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## 6. SPLICING WELDED WIRE FABRIC

Welded wire fabric shall be spliced in the following manner:

- a. Adjacent sections shall be spliced end to end by either:
  - (1) Overlapping the two pieces of fabric one full mesh (measured from the ends of the longitudinal wires in one piece to the ends of the longitudinal wires in the other piece) and securing the two pieces together with wire ties placed at intervals of 18 inches; or,
  - (2) Overlapping the two pieces of fabric so that the end crosswire of each piece comes in contact with the next-to-end crosswire of the other piece and securing the two pieces together only as required to keep the fabric in place and to prevent it from curling.
- b. Adjacent sections of fabric shall be spliced side to side by either:
  - (1) Placing the two selvage wires (the longitudinal wires at the edges of the fabric) one along side and overlapping the other and securing the two pieces together with wire ties placed at intervals of 3 feet; or,
  - (2) Placing each selvage wire in the middle of the first mesh of the other section of fabric and securing it to the other section at intervals of 10 feet by means of wire ties placed on the selvage wires alternately at intervals of 5 feet.
  - (3) Placing each selvage wire in contact with the next-to-edge longitudinal wire and securing them together only as required to keep the fabric in place or to prevent it from curling.

## 7. PLACING

Reinforcement shall be accurately placed and secured in position in a manner that will prevent its displacement during the placement of concrete. Tack welding of bars will not be permitted. Metal chairs, metal hangers, metal spacers and concrete chairs

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may be used to support the reinforcement. Metal hangers, spacers and ties shall be placed in such a manner that they will not be exposed in the finished concrete surface. The legs of metal chairs that may be exposed at the lower face of slabs or beams shall be galvanized as specified for iron and steel hardware in Material Specification 582. Precast concrete chairs shall be manufactured of the same class of concrete as that specified for the structure and shall have tie wires securely anchored in the chair or a V-shaped groove at least 3/4 inch in depth molded into the upper surface to receive the steel bar at the point of support. Precast concrete chairs shall be moist at the time concrete is placed.

Reinforcement shall not be placed until the prepared site has been inspected and approved by the Engineer. After placement of the reinforcement, concrete shall not be placed until the reinforcement has been inspected and approved by the Engineer.

#### 8. MEASUREMENT AND PAYMENT

(Option 1) For items of work for which specific unit prices are established in the contract, the weight of reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest pound by computation from the placing drawings. Measurement of hooks and bends will be based on the requirements of ACI Standard 315. Computation of weights of reinforcement will be based on the unit weights established in Tables 34-1, 34-2, and 34-3. The area of welded wire fabric reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest square foot by computation from the placing drawings with no allowance for laps. The weight of steel reinforcing in extra splices or extra-length splices approved for the convenience of the Contractor or the weight of supports and ties will not be included in the measurement for payment.

Payment for furnishing and placing reinforcing steel will be made at the contract unit price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work including preparing and furnishing bar schedules, lists or diagrams; furnishing and attaching ties and supports; and furnishing, transporting, cutting, bending, cleaning and securing all reinforcement.

(Option 2) For items of work for which specific unit prices are established in the contract, the weight of bar reinforcement placed in the concrete in accordance with the drawings will be determined

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to the nearest pound by computation from the placing drawings. Measurement of hooks and bends will be based on the requirements of ACI Standard 315. Computation of weights of bar reinforcement will be based on the unit weights established in Table 34-1. The weight of steel reinforcing in extra splices or extra-length splices approved for the convenience of the Contractor or the weight of supports and ties will not be included in the measurement for payment.

The area of welded wire fabric reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest square foot by computation from the placing drawings with no allowance for laps.

Payment for furnishing and placing bar reinforcing steel will be made at the contract unit price for bar reinforcement. Payment for furnishing and placing welded wire fabric reinforcing steel will be made at the contract unit price for welded wire fabric reinforcement. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work including preparing and furnishing bar schedules, lists or diagrams; furnishing and attaching ties and supports; and furnishing, transporting, cutting, bending, cleaning and securing all reinforcement.

(Use with Either Option) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and items to which they are made subsidiary are identified in Section 9 of this specification.

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TABLE 34-1. STANDARD REINFORCING BARS

Bar Size No.	2	3	4	5	6	7	8	9	10	11
Wt. (lb./ft.)	0.167	0.376	0.668	1.043	1.502	2.044	2.670	3.400	4.303	5.313

TABLE 34-2. RECTANGULAR WELDED WIRE FABRIC <sup>1</sup>

Style Designation	Wt. in Lb. Per 100 Sq. Ft.	Style Designation	Wt. in Lb. Per 100 Sq. Ft.	Style Designation	Wt. in Lb. Per 100 Sq. Ft.
24-1414	16	312- 711	39	48- 912	23
212- 04	169	312- 812	32	48-1012	20
212- 15	144	412- 26	69	48-1112	17
212- 26	124	412- 37	59	48-1212	14
212- 37	107	412- 48	51	48-1214	12
212- 48	91	412- 59	43	612-3/04	91
212- 59	77	412- 610	36	612-2/04	78
212- 610	66	412- 711	31	612- 00	81
212- 711	56	412- 810	27	612- 03	72
312- 04	119	412- 812	25	612- 11	69
312- 15	102	412- 912	22	612- 14	61
312- 26	87	412-1012	19	612- 22	59
312- 37	75	412-1112	16	612- 25	52
312- 48	64	412-1212	13	612- 33	51
312- 59	54	48- 711	33	612- 44	44
312- 610	46	48- 812	27	612- 66	32
				612- 77	27

<sup>1</sup>Style designation is defined in ACI Standard 315 of the American Concrete Institute.

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TABLE 34-3. SQUARE WELDED WIRE FABRIC<sup>1</sup>

Style Designation	Wt. in Lb. Per 100 Sq. Ft.	Style Designation	Wt. in Lb. Per 100 Sq. Ft.
2 x 2 - 10/10	60	4 x 4 - 14/14	11
2 x 2 - 12/12	37	6 x 6 - 0/0	107
2 x 2 - 14/14	21	6 x 6 - 1/1	91
2 x 2 - 16/16	13	6 x 6 - 2/2	78
3 x 3 - 8/8	58	6 x 6 - 3/3	68
3 x 3 - 10/10	41	6 x 6 - 4/4	58
3 x 3 - 12/12	25	6 x 6 - 4/6	50
3 x 3 - 14/14	14	6 x 6 - 5/5	49
4 x 4 - 4/4	85	6 x 6 - 6/6	42
4 x 4 - 6/6	62	6 x 6 - 7/7	36
4 x 4 - 8/8	44	6 x 6 - 8/8	30
4 x 4 - 10/10	31	6 x 6 - 9/9	25
4 x 4 - 12/12	19	6 x 6 - 10/10	21
4 x 4 - 13/13	14		

<sup>1</sup>Style designation is defined in ACI Standard 315 of the American Concrete Institute.

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 41REINFORCED CONCRETE PRESSURE PIPE SPILLWAY CONDUITS1. Applicability.

Construction Specification 41 is applicable to the construction of principal spillway conduits appurtenant to earth dams using bedded or cradled reinforced concrete pressure pipe. It may also be applied to the construction of any type of reinforced concrete pipe conduit that crosses under or through an earth dam.

2. Material Specifications.

The following specifications are complementary to Construction Specification 41:

a. Reinforced Concrete Pressure Pipe.

Specification 541

b. Joint Sealing Compound.

Specification 536

c. Preformed Expansion Joint Filler.

Specification 535

3. Items to be Included in Contract Specifications and Drawings.

- a. Line and grade of the conduit.
- b. Details of the pipe bedding or cradle, including joint details.
- c. Excavation and backfill requirements, if applicable.
- d. Pay limits or actual limits for excavation.
- e. Details of wall fittings and other special pipe fittings.
- f. Special requirements for foundation preparation.
- g. Type of pipe.
- h. Size of pipe.
- i. Strength of pipe in terms of three-edge bearing strength and internal pressure.

- j. Maximum allowable offset in alignment of interior pipe surface at joints, if tolerance is limited by cavitation hazard.
- k. Minimum joint length and minimum limiting angle of the joints according to definitions in Material Specification 541.
- l. Type and class of expansion joint filler.
- m. Class of concrete for bedding or cradle and support blocks.
- n. Statement that metal strips covering the joints as specified in Section 4 are not required, if applicable. (If the conduit rests on bedrock so no appreciable movement will take place at the joints, metal cover strips generally will not be needed.)

#### 4. Discussion of Options.

##### a. Section 3, Laying the Pipe.

- (1) Option 1 is the preferred method of stating the instructions for connecting pipe sections.
- (2) Option 2 is intended for use when special problems are anticipated or when the pipe to be furnished requires special methods of connection.

##### b. Section 5, Pressure Testing.

- (1) Option 1 is considered adequate for principal spillway conduits that will operate under pressure intermittently at normal frequencies.
- (2) Option 2 may be required for principal spillway conduits that will operate under pressure for extended periods of time or at very frequent intervals.

##### c. Section 6, Measurement and Payment.

- (1) Option 1 must be used when it is desired to base payment on the measurement of the laid length of the conduit.
- (2) Option 2 must be used when it is desired to base payment on the summation of the nominal laying lengths of the pipe sections used.

Both options may be included as numbered methods in standard specifications. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

Both Methods. The following provisions apply to both methods of measurement and payment.

CONSTRUCTION SPECIFICATION (GUIDE)41. REINFORCED CONCRETE PRESSURE PIPE SPILLWAY CONDUITS1. SCOPE

The work shall consist of furnishing and installing reinforced concrete pressure pipe, fittings and accessories in principal spillway conduits appurtenant to earth dams.

2. MATERIALS

Reinforced concrete pressure pipe, fittings and accessories shall conform to the requirements of Material Specification 541.

Portland cement concrete for bedding and cradles shall conform to the requirements of Construction Specification 31 for the specified class of concrete.

Joint sealing compound shall conform to the requirements of Material Specification 536.

Preformed expansion joint filler shall conform to the requirements of Material Specification 535.

3. LAYING THE PIPE

The pipe shall be set to the specified line and grade and temporarily supported on precast concrete blocks or wedges. Bell and spigot pipe shall be laid with the bell upstream.

Just before each joint is connected the connecting surfaces of the bell and spigot or spigots and sleeve shall be thoroughly cleaned and dried, and the rubber gasket and the inside surface of the bell or sleeve shall be lubricated with a light film of soft vegetable soap compound (flax soap). The rubber gasket shall be stretched uniformly as it is placed in the spigot groove to insure a uniform volume of rubber around the circumference of the pipe.

(Option 1) The joint shall be connected by means of a pulling or jacking force so applied to the pipe that the spigot enters squarely into the bell.

(Option 2) The joint shall be connected in accordance with the manufacturer's instructions.

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(Use with Either Option) When the spigot has been seated to within 1/2-inch of its final position, the position of the gasket in the joint shall be checked around the entire circumference of the pipe by means of a metal feeler gage. In any case where the gasket is found to be displaced, the joint shall be disengaged and properly reconnected. After the position of the gasket has been checked, the spigot shall be completely pulled into the bell and the section of pipe shall be adjusted to line and grade.

#### 4. FILLING JOINTS

Before the placement of the bedding or cradle, the exterior annular space between the ends of the pipe sections shall be cleaned and completely filled with joint sealing compound. Before the compound is applied, the surfaces against which it is to be placed shall be cleaned of all dust, lubricant and other substances that would interfere with a bond between the compound and the pipe. If recommended by the manufacturer of the compound, the concrete surfaces shall be coated with a primer in accordance with the manufacturer's recommendations. Primers shall be applied to the concrete surfaces only and shall not come in contact with the gasket or gasket sealing surfaces. Unless the compound or primer is specifically recommended for use on moist concrete, the surfaces shall be dry when it is applied.

The joint sealing compound shall be allowed to cure until it is sufficiently firm to prevent the entry of concrete or earth into the joint before concrete, bedding or backfill is placed against it. Unless otherwise specified, where bedding or backfill containing particles larger than one-fourth inch in maximum dimension is to be placed within 6 inches of the joint sealing compound, the compound shall be covered before the bedding or backfill is placed with a strip of 16-gage to 24-gage metal at least 2 inches wider than the space between the ends of the pipe sections.

#### 5. PRESSURE TESTING

(Option 1) Pressure testing of the completed conduit will not be required.

(Option 2) Prior to the placement of any concrete or earth fill around the conduit or filling of the pipe joints, the conduit shall be tested for leaks in the following manner: The ends of the conduit shall be plugged and a standpipe with a minimum diameter of two (2) inches shall be attached to the upstream plug. The conduit shall be braced at each end to prevent slippage. The conduit and the standpipe shall be filled with water. The water level in the standpipe shall be maintained by continuous pumping a minimum of

10 feet above the invert of the upstream end of the conduit for a period of not less than two hours. Any leaks that occur during this period shall be repaired by a method satisfactory to the Engineer. After repair, the conduit shall be tested again as described above and the procedure shall be repeated until the conduit is accepted as watertight by the Engineer.

The pipe joints shall show no leakage. Damp spots developing on the surface of the pipe will not be considered as leakage.

6. MEASUREMENT AND PAYMENT

(Option 1) For items of work for which specific unit prices are established in the contract, the quantity of each size, type and class of pipe will be determined to the nearest 0.1 foot by measurement of the laid length of pipe along the invert centerline of the conduit. Payment for each size, type and class of reinforced concrete pressure pipe will be made at the contract unit price for that size, type and class of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe complete in place including accessories such as wall fittings, joint gaskets, coupling bands, sleeves or collars and all other items necessary and incidental to the completion of the work.

(Option 2) For items of work for which specific unit prices are established in the contract, the quantity of each size, type and class of pipe will be determined as the sum of the nominal laying lengths of the pipe sections used. Payment for each size, type and class of reinforced concrete pressure pipe will be made at the contract unit price for that size, type and class of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe complete in place including accessories such as wall fittings, joint gaskets, coupling bands, sleeves or collars and all other items necessary and incidental to the completion of the work.

(Use with Either Option) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 42CONCRETE PIPE CONDUITS AND DRAINS1. Applicability.

Construction Specification 42 is applicable to all types of concrete pipe conduits except principal spillway conduits for earth dams. It may be applied to culverts, to pipe collector systems in structure drains, to irrigation pipelines, or to portions of land drainage systems.

2. Material Specifications.

The following specifications are complementary to Construction Specification 42:

a. Reinforced Concrete Pressure Pipe.

Specification 541

b. Concrete Culvert Pipe.

Specification 542

c. Concrete Irrigation Pipe, Drainage Pipe, and Drain Tile.

Specification 543

d. Joint Sealing Compound.

Specification 536

e. Preformed Expansion Joint Filler.

Specification 535

3. Items to be Included in Contract Specifications and Drawings.

## a. Line and grade of the conduit.

## b. Details of concrete bedding or cradle, including class of concrete, joint details, and type of expansion joint filler.

## c. Details of earth, sand, or gravel bedding, including description and grading limits of the bedding material.



- d. Excavation and backfill requirements, if applicable.
- e. Pay limits or actual limits for excavation and backfill, if required.
- f. Special requirements for foundation preparation.
- g. Kind of pipe or tile by name and class. (See appropriate reference specifications.)
- h. Size of pipe or tile.
- i. Type of cement for pipe or tile if a certain type is necessary because of soil, water, or other environmental conditions.
- j. Strength of pipe, if not covered by reference specifications, in terms of three-edge-bearing load and internal pressure as appropriate.
- k. Type of joint and details of banded joints or other special joints.
- l. Details of wall fittings and other special fittings and appurtenances.
- m. Test pressure, if applicable.
- n. Method of measurement and payment if the standard specification includes more than one method.

4. Discussion of Options.

a. Section 5a, Rubber Gasket Joint, Pressure Pipe.

Option 1 is the preferred method of stating the instructions for connecting pipe sections.

Option 2 is intended for use when special problems are anticipated or when the pipe to be furnished requires special methods of connection.

b. Section 9, Pressure Testing.

The options are self-explanatory. The choice of option must be consistent with the function of the conduit and the required operating pressure.

c. Section 10, Measurement and Payment.

Option 1 must be used when it is desired to base payment on the measurement of the laid length of the conduit.

Option 2 must be used when it is desired to base payment on the summation of the nominal laying lengths of the pipe sections used.

Both options may be included as numbered methods in the standard specification. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

Both Methods. The following provisions apply to both methods of measurement and payment.



CONSTRUCTION SPECIFICATION (GUIDE)42. CONCRETE PIPE CONDUITS AND DRAINS1. SCOPE

The work shall consist of furnishing and installing concrete pipe or concrete drain tile and the necessary fittings as shown on the drawings.

2. MATERIALS

Reinforced concrete pressure pipe shall conform to the requirements of Material Specification 541 for the type and strength specified.

Concrete culvert pipe shall conform to the requirements of Material Specification 542 for the kind of pipe specified.

Concrete irrigation pipe, drainage pipe and drain tile shall conform to the requirements of Material Specification 543 for the kind of pipe or tile specified.

Pipe fittings shall conform to the requirements of the applicable pipe specifications.

Sealing compound for filling rubber gasket joints shall conform to the requirements of Material Specification 536.

Hot-pour joint sealer shall conform to the requirements of Federal Specification SS-S-169.

Cold-applied sealing compound shall conform to the requirements of Federal Specification SS-S-168.

Preformed sealing compound shall conform to the requirements of Interim Federal Specification SS-S-00210.

Joint packing shall conform to the requirements of Federal Specification HH-P-119 for mastic sealed joints and Federal Specification HH-P-117 for cement mortar sealed joints.

Preformed expansion joint filler shall conform to the requirements of Material Specification 535.

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### 3. LAYING AND BEDDING

Pipe and tile shall be laid to the line and grade shown on the drawings. Pipe shall be laid with the bell or groove at the upstream end of each section.

- a. Concrete Cradles or Bedding. Pipe to be cradled or bedded on concrete shall be set to the specified line and grade and temporarily supported on precast concrete blocks or wedges until the cradle or bedding concrete is placed. Concrete blocks or wedges used to temporarily support the pipe during placement of bedding or cradle shall be of a class of concrete equal to or better than that used in the bedding or cradle.
- b. Earth, Sand, or Gravel Bedding. The pipe shall be firmly and uniformly bedded throughout its entire length to the depth and in the manner specified on the drawings. The pipe shall be loaded sufficiently during backfilling around the sides to prevent its being lifted from the bedding.

Perforated pipe shall be laid with the perforations down and oriented symmetrically about a vertical centerline. Perforations shall be clear of any obstructions when the pipe is laid.

### 4. JOINTS

Pipe joints shall conform to the details shown on the drawings and to the requirements of Section 5 and 6 of this specification applicable to the type of joint specified. Except where unsealed joints are indicated, pipe joints shall be sound and watertight at the pressure specified.

### 5. JOINING BELL AND SPIGOT PIPE

- a. Rubber Gasket Joint, Pressure Pipe. Just before the joint is connected the connecting surfaces of the spigot and the bell or coupling band, sleeve or collar shall be thoroughly cleaned and dried, and the rubber gasket and the inside surface of the bell or coupling band, sleeve or collar shall be lubricated with a light film of soft vegetable soap compound (flax soap). The rubber gasket shall be stretched uniformly as it is placed in the spigot groove to insure a uniform volume of rubber around the circumference of the pipe.

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(Option 1) The joint shall be connected by means of a pulling or jacking force so applied to the pipe that the spigot enters squarely into the bell.

(Option 2) The joint shall be connected in accordance with the manufacturer's recommendations.

(Use with Either Option) When the spigot has been seated to within 1/2 inch of its final position, the position of the gasket in the joint shall be checked around the entire circumference of the pipe by means of metal feeler gage. In any case where the gasket is found to be displaced, the joint shall be disengaged and properly reconnected. After the position of the gasket has been checked, the spigot shall be completely pulled into the bell and the section of the pipe shall be adjusted to line and grade.

- b. Rubber Gasket Joints, Sewer and Culvert Pipe or Irrigation Pipe. The pipe shall be joined in accordance with the gasket manufacturer's recommendations except as otherwise specified.
- c. Mastic Sealed Joints. At the time of assembly the inside surfaces of the bell and the outside surfaces of the spigot shall be clean, dry and primed as recommended by the manufacturer of the sealing compound. A closely twisted gasket of joint packing of the diameter required to support the spigot at the proper grade and to make the joint concentric shall be made in one piece of sufficient length to pass around the pipe and lap at the top. The gasket shall be laid in the bell throughout the lower third of the circumference. The end of the spigot shall be laid on the gasket and the spigot shall be fully inserted into the bell so that the pipe sections are closely fitted and aligned. The gasket then shall be lapped at the top of the pipe and thoroughly packed into the annular space between the bell and the spigot.
- (1) Hot-Pour Joint Sealer. The sealing compound shall be heated to within the temperature range recommended by the manufacturer and shall not be overheated or subjected to prolonged heating. After the joint is assembled, with the pipe in its final location, a suitable joint runner shall

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be placed around the joint with an opening left at the top. Molten sealing compound shall be poured into the joint as rapidly as possible without entrapping air until the annular space between bell and spigot is completely filled. After the compound has set, the runner may be removed. Alternate joints may be poured before the pipe is lowered into the trench. In this case, the joint shall be poured with the pipe in a vertical position without the use of the runner. The compound shall have thoroughly set before the pipe is placed in the trench, and the pipe shall be handled so as to cause no deformation of the joint during placement.

- (2) Cold-Applied Sealing Compound. The annular space between bell and spigot shall be completely filled with the sealing compound. The compound shall be mixed on the job in accordance with the manufacturer's recommendations and in relatively small quantities so that setting will not be appreciable before application.
- (3) Preformed Sealing Compound. Joint packing will not be required, except as recommended by the manufacturer of the sealing compound. Preformed strips or bands of the sealing compound shall be applied to the bell and spigot prior to assembly of the joint in accordance with the manufacturer's recommendations. Any compound extruded from the interior side of the joint during assembly shall be trimmed even with the interior surface of the pipe.
- d. Cement Mortar Sealed Joints. Cement mortar for joints shall consist of one part by weight of portland cement and two parts by weight of fine sand with enough water added to produce a workable consistency. At the time of assembly the inside surface of the bell and the outside surface of the spigot shall be clean and moist.
- (1) With Packing. A closely twisted gasket of joint packing of the diameter required to support the spigot at the proper grade and to make the joint concentric shall be made in one piece of sufficient

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length to pass around the pipe and lap at the top. The gasket shall be saturated with neat cement grout, laid in the bell throughout the lower third of the circumference and covered with mortar. The end of the spigot shall be fully inserted into the bell so that the pipe sections are closely fitted and aligned. A small amount of mortar shall be placed in the annular space throughout the upper two-thirds of the circumference. The gasket then shall be lapped at the top of the pipe and thoroughly packed into the annular space between the bell and the spigot. The remainder of the annular space then shall be filled completely with mortar and beveled off at an angle of approximately forty-five (45) degrees with the outside of the bell. If the mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheesecloth. After the mortar has set slightly, the joint shall be wiped inside the pipe. In pipe too small for a man to work inside, wiping may be done by dragging an approved swab through the pipe as the work progresses.

- (2) Without Packing. The lower portion of the bell shall be filled with stiff mortar of sufficient thickness to make the inner surface of the abutting sections flush. The spigot end of the pipe to be joined shall be fully inserted into the bell so that the sections are closely fitted and aligned. The remaining annular space between the bell and spigot shall then be filled with mortar and the mortar neatly beveled off at an angle of approximately forty-five (45) degrees with the outside of the bell. After the mortar has set slightly, the joint shall be wiped inside the pipe. In pipe too small for a man to work inside, wiping may be done by dragging an approved swab through the pipe as the work progresses.

- e. Unsealed Joints. When unsealed joints are specified, they shall conform to the details shown on the drawings.

## 6. JOINING TONGUE AND GROOVE PIPE

- a. Cement Mortar Sealed Joint. Mortar shall be as specified for bell and spigot joints. The tongue end of the section

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being placed shall be covered with mortar and firmly pressed into the groove of the laid section in such a manner that the tongue fits snugly and truly in the groove and that mortar is squeezed out both on the interior and exterior of the joint. Care shall be taken that no mortar falls from the groove end during the abutting operation. Immediately after the pipe sections have been abutted, exposed external surface mortar shall be pressed into the joint and any excess mortar removed, after which the interior surface of the joint shall be carefully pointed and brushed smooth, and all surplus mortar removed.

- b. Mastic Sealed Joints. Strips or bands of preformed sealing compound shall be applied to the tongue and groove prior to assembly of the joint in accordance with the manufacturer's recommendations. Any compound extruded from the interior side of the joint during assembly shall be trimmed even with the interior surface of the pipe.
- c. Rubber Gasket Joints. The pipe shall be joined in accordance with the gasket manufacturer's recommendations except as otherwise specified.
- d. Unsealed Joints. When unsealed joints are specified, they shall conform to the details shown on the drawings.

## 7. BANDING

When external mortar bands are specified, they shall conform to the details shown on the drawings.

## 8. CURING MORTAR JOINTS AND BANDS

The external surfaces of mortar joints shall be covered with moist earth, sand, canvas, burlap or other approved materials and shall be kept moist for 10 days or until the pipe is backfilled.

Water shall not be turned into the conduit within 24 hours after the joints are finished. Hydrostatic pressure shall not be applied to the conduit prior to 14 days after the joints are finished.

## 9. PRESSURE TESTING

(Option 1) Pressure testing of the completed conduit will not be required.

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(Option 2) Prior to the placement of concrete or earth fill around the conduit, the conduit shall be tested for leaks in the following manner: The ends of the conduit shall be plugged and a standpipe with a minimum diameter of two (2) inches shall be attached to the upstream plug. The conduit shall be braced at each end to prevent slippage. The conduit and the standpipe shall be filled with water. The water level in the standpipe shall be maintained, by continuous pumping, a minimum of 10 feet above the invert of the upstream end of the conduit for a period of not less than two hours. Any leaks shall be repaired and the conduit shall be retested as described above. The procedure shall be repeated until the conduit is watertight.

The pipe joints shall show no leakage. Damp spots developing on the surface of the pipe will not be considered as leaks.

(Option 3) Prior to the placement of concrete or earth fill around the conduit, the conduit shall be tested at the specified test pressure for a period of at least 2 hours. Any leaks shall be repaired and the conduit shall be retested. The procedure shall be repeated until the conduit is watertight.

The pipe joints shall show no leakage. Damp spots developing on the surface of the pipe will not be considered as leaks.

10. MEASUREMENT AND PAYMENT

(Option 1) For items of work for which specific unit prices are established in the contract, the quantity of each kind, size, and class of pipe or tile will be determined to the nearest foot by measurement of the laid length along the invert centerline of the conduit. Payment for each kind, size, and class of pipe or tile will be made at the contract unit price for that kind, size, and class. Such payment will constitute full compensation for furnishing, transporting and installing the pipe or tile complete in place.

(Option 2) For items of work for which specific unit prices are established in the contract, the quantity of each kind, size, and class of pipe or tile will be determined as the sum of the nominal laying lengths of the sections used. Payment for each kind, size, and class of pipe or tile will be made at the contract unit price for that kind, size, and class. Such payment will constitute full compensation for furnishing, transporting and installing the pipe or tile complete in place.

(42-7)

(Use with Either Option) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 11 of this specification.

(42-8)

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 43CLAY PIPE CONDUITS AND DRAINS1. Applicability.

Construction Specification 43 is applicable to all types of clay pipe conduits. It may be applied to pipe collector systems in structure drains or to portions of land drainage systems.

2. Material Specifications.

The following specifications are complementary to Construction Specification 43:

a. Clay Pipe and Clay Drain Tile.

Specification 544

b. Joint Sealing Compound.

Specification 536

3. Items to be Included in Contract Specifications and Drawings.

- a. Line and grade of the conduit.
- b. Details of the bedding, including description and grading limits of the bedding material.
- c. Excavation and backfill requirements, if applicable.
- d. Pay limits or actual limits for excavation and backfill, if required.
- e. Kind and class of pipe or tile.
- f. Size of pipe or tile.
- g. Type of joint and details of special joints.
- h. Details of wall fittings and other special fittings and appurtenances.
- i. Pressure test requirements, if applicable.



- j. Method of measurement and payment if the standard specification includes more than one method.

4. Discussion of Options.

Section 6, Measurement and Payment.

Option 1 must be used when it is desired to base payment on the measurement of the laid length of the conduit.

Option 2 must be used when it is desired to base payment on the summation of the nominal laying lengths of the pipe sections used.

Both options may be included as numbered methods in the standard specification. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

Both Methods. The following provisions apply to both methods of measurement and payment.

CONSTRUCTION SPECIFICATION (GUIDE)43. CLAY PIPE CONDUITS AND DRAINS1. SCOPE

The work shall consist of furnishing and installing clay pipe or clay drain tile and the necessary fittings as shown on the drawings.

2. MATERIALS

Pipe, drain tile, and fittings shall conform to the requirements of Material Specification 544 for the kind of pipe or tile specified.

Sealing compound for filling rubber gasket joints shall conform to the requirements of Material Specification 536.

Compression joints using resilient materials shall conform to the requirements of ASTM Specification C 425.

Hot-pour joint sealer shall conform to the requirements of Federal Specification SS-S-169.

Cold-applied sealing compound shall conform to the requirements of Federal Specification SS-S-168.

Preformed sealing compound shall conform to the requirements of Interim Federal Specification SS-S-00210.

Joint packing shall conform to the requirements of Federal Specification HH-P-119 for mastic sealed joints and Federal Specification HH-P-117 for cement mortar sealed joints.

3. LAYING AND BEDDING

Pipe and tile shall be laid to the line and grade shown on the drawings. Pipe shall be laid with the bell at the upstream end of each section.

The pipe shall be firmly and uniformly bedded throughout its entire length to the depth and in the manner specified on the drawings. The pipe shall be loaded sufficiently during backfilling around the sides to prevent its being lifted from the bedding.

(43-1)

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Perforated pipe and tile shall be laid with the perforations down and oriented symmetrically about the vertical centerline. Perforations shall be clear of any obstructions when the pipe is laid.

#### 4. JOINTS

Pipe joints shall conform to the details shown on the drawings and, except where unsealed joints are indicated, shall be sound and watertight at the pressures specified.

- a. Rubber Gasket Joints. Rubber gasket joints shall be assembled in accordance with the gasket manufacturer's recommendations except as otherwise specified.
- b. Compression Joints. Compression joints using resilient materials shall be assembled in accordance with the manufacturer's recommendations.
- c. Mastic Sealed Joints. At the time of assembly the inside surfaces of the bell and the outside surfaces of the spigot shall be clean, dry and primed as recommended by the manufacturer of the sealing compound. A closely twisted gasket of joint packing of the diameter required to support the spigot at the proper grade and to make the joint concentric shall be made in one piece of sufficient length to pass around the pipe and lap at the top. The gasket shall be laid in the bell throughout the lower third of the circumference. The end of the spigot shall be laid on the gasket and the spigot shall be fully inserted into the bell so that the pipe sections are closely fitted and aligned. The gasket then shall be lapped at the top of the pipe and thoroughly packed into the annular space between the bell and the spigot.
- (1) Hot-Pour Joint Sealer. The sealing compound shall be heated to within the temperature range recommended by the manufacturer and shall not be overheated or subjected to prolonged heating. After the joint is assembled, with the pipe in its final location, a suitable joint runner shall be placed around the joint with an opening left at the top. Molten sealing compound shall be poured into the joint as rapidly as possible without entrapping air until the annular space between bell and spigot is completely filled. After the compound

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has set, the runner may be removed. Alternate joints may be poured before the pipe is lowered into the trench. In this case the joint shall be poured with the pipe in a vertical position without the use of the runner. The compound shall have thoroughly set before the pipe is placed in the trench, and the pipe shall be handled so as to cause no deformation of the joint during placement.

- (2) Cold-Applied Sealing Compound. The annular space between bell and spigot shall be completely filled with the sealing compound. The compound shall be mixed on the job in accordance with the manufacturer's recommendations and in relatively small quantities so that setting will not be appreciable before application.
- (3) Preformed Sealing Compound. Joint packing will not be required, except as recommended by the manufacturer of the sealing compound. Preformed strips or bands of the sealing compound shall be applied to the bell and spigot prior to assembly of the joint in accordance with the manufacturer's recommendations. Any compound extruded from the interior side of the joint during assembly shall be trimmed even with the interior surface of the pipe.

d. Cement Mortar Sealed Joints. Cement mortar for joints shall consist of one part by weight of portland cement and two parts by weight of fine sand with enough water added to produce a workable consistency. At the time of assembly the inside surface of the bell and the outside surface of the spigot shall be clean and moist.

- (1) With Packing. A closely twisted gasket of joint packing of the diameter required to support the spigot at the proper grade and to make the joint concentric shall be made in one piece of sufficient length to pass around the pipe and lap at the top. The gasket shall be saturated with neat cement grout, laid in the bell throughout the lower third of the circumference and covered with mortar. The end of the spigot shall be fully inserted into the bell so that the pipe sections are closely fitted and aligned. A small amount of mortar shall be placed in the annular space throughout the upper

(43-3)



two-thirds of the circumference. The gasket then shall be lapped at the top of the pipe and thoroughly packed into the annular space between the bell and the spigot. The remainder of the annular space then shall be filled completely with mortar and beveled off at an angle of approximately forty-five (45) degrees with the outside of the bell. If the mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheesecloth. After the mortar has set slightly, the joint shall be wiped inside the pipe. In pipe too small for a man to work inside, wiping may be done by dragging an approved swab through the pipe as the work progresses.

- (2) Without Packing. The lower portion of the bell shall be filled with stiff mortar of sufficient thickness to make the inner surface of the abutting sections flush. The spigot end of the pipe to be joined shall be fully inserted into the bell so that the sections are closely fitted and aligned. The remaining annular space between the bell and spigot shall then be filled with mortar and the mortar neatly beveled off at an angle of approximately forty-five (45) degrees with the outside of the bell. After the mortar has set slightly, the joint shall be wiped inside the pipe. In pipe too small for a man to work inside, wiping may be done by dragging an approved swab through the pipe as the work progresses.

- e. Unsealed Joints. When unsealed joints are specified, they shall conform to the details shown on the drawings.

## 5. CURING MORTAR JOINTS

The external surfaces of mortar joints shall be covered with moist earth, sand, canvas, burlap or other approved materials and shall be kept moist for 10 days or until the pipe is backfilled.

Water shall not be turned into the conduit within 24 hours after the joints are finished.

## 6. MEASUREMENT AND PAYMENT

(Option 1) For items of work for which specific unit prices are established in the contract, the quantity of each kind, size, and class of pipe or tile will be determined to the nearest foot by measurement of the laid length along the invert centerline of the

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conduit. Payment for each kind, size, and class of pipe or tile will be made at the contract unit price for that kind, size, and class. Such payment will constitute full compensation for furnishing, transporting and installing the pipe or tile complete in place.

(Option 2) For items of work for which specific unit prices are established in the contract, the quantity of each kind, size, and class of pipe or tile will be determined as the sum of the nominal laying lengths of the sections used. Payment for each kind, size, and class of pipe or tile will be made at the contract unit price for that kind, size, and class. Such payment will constitute full compensation for furnishing, transporting and installing the pipe or tile complete in place.

(Use with Either Option) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specifications.



INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 44ASBESTOS-CEMENT PIPE CONDUITS AND DRAINS1. Applicability.

Construction Specification 44 is applicable to all types of asbestos-cement pipe conduits. It may be applied to pipe collector systems in structure drains, to irrigation pipelines, or to portions of land drainage systems.

2. Material Specifications.

Material Specification 545 is complementary to Construction Specification 44.

3. Items to be Included in Contract Specifications and Drawings.

- a. Line and grade of the conduit.
- b. Details of concrete bedding or cradle, including class of concrete, joint details, and type of expansion joint filler.
- c. Details of earth, sand, or gravel bedding, including description and grading limits of the bedding material.
- d. Excavation and backfill requirements, if applicable.
- e. Pay limits or actual limits for excavation and backfill, if required.
- f. Kind of pipe and class where applicable.
- g. Size of pipe.
- h. Type of joint and details of special joints.
- i. Details of wall fittings and other special fittings and appurtenances.
- j. Test pressure, if applicable.
- k. Method of measurement and payment if the standard specification includes more than one method.



4. Discussion of Options.

a. Section 5, Pressure Testing.

The options are self-explanatory. The choice of option must be consistent with the function of the conduit and the required operating pressure.

b. Section 6, Measurement and Payment.

Option 1 must be used when it is desired to base payment on the measurement of the laid length of the conduit.

Option 2 must be used when it is desired to base payment on the summation of the nominal laying lengths of the pipe sections used.

Both options may be included as numbered methods in the standard specification. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

Both Methods. The following provisions apply to both methods of measurement and payment.

CONSTRUCTION SPECIFICATION (GUIDE)44. ASBESTOS-CEMENT PIPE CONDUITS AND DRAINS1. SCOPE

The work shall consist of furnishing and installing asbestos-cement pipe and the necessary fittings as shown on the drawings.

2. MATERIALS

Pipe, fittings, and gaskets shall conform to the requirements of Material Specification 545 for the kind of pipe specified.

3. LAYING AND BEDDING

Pipe shall be laid to the line and grade shown on the drawings.

- a. Concrete Cradle or Bedding. Pipe to be cradled or bedded on concrete shall be set to the specified line and grade and temporarily supported on concrete blocks or wedges until the cradle or bedding concrete is placed.
- b. Earth, Sand, or Gravel Bedding. The pipe shall be firmly and uniformly bedded throughout its entire length to the depth and in the manner specified on the drawings. The pipe shall be loaded sufficiently during backfilling around the sides to prevent its being lifted from the bedding.

Perforated pipe shall be laid with the perforations down and oriented symmetrically about the vertical centerline. Perforations shall be clear of any obstructions when the pipe is laid.

4. JOINTS

Pipe joints shall conform to the details shown on the drawings and, except where unsealed joints are indicated, shall be sound and watertight at the pressures specified.

Pipe shall be installed and joined in accordance with the manufacturer's recommendations except as otherwise specified.

5. PRESSURE TESTING

(Option 1) Pressure testing of the completed conduit will not be required.

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(Option 2) Prior to the placement of concrete or earth fill around the conduit, the conduit shall be tested for leaks in the following manner: The ends of the conduit shall be plugged and a standpipe with a minimum diameter of two (2) inches shall be attached to the upstream plug. The conduit shall be braced at each end to prevent slippage. The conduit and the standpipe shall be filled with water. The water level in the standpipe shall be maintained by continuous pumping, a minimum of 10 feet above the invert of the upstream end of the conduit for a period of not less than two hours. Any leaks shall be repaired and the conduit shall be retested as described above. The procedure shall be repeated until the conduit is watertight.

The pipe joints shall show no leakage. Damp spots developing on the surface of the pipe will not be considered as leaks.

(Option 3) Prior to the placement of concrete or earth fill around the conduit, the conduit shall be tested at the specified test pressure for a period of at least 2 hours. Any leaks shall be repaired and the conduit shall be retested. The procedure shall be repeated until the conduit is watertight.

The pipe joints shall show no leakage. Damp spots developing on the surface of the pipe will not be considered as leaks.

## 6. MEASUREMENT AND PAYMENT

(Option 1) For items of work for which specific unit prices are established in the contract, the quantity of each kind, size, and class of pipe will be determined to the nearest foot by measurement of the laid length of pipe along the invert centerline of the conduit. Payment for each kind, size, and class of pipe will be made at the contract unit price for that kind, size, and class of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe complete in place.

(Option 2) For items of work for which specific unit prices are established in the contract, the quantity of each kind, size, and class of pipe will be determined as the sum of the nominal laying lengths of the pipe sections used. Payment for each kind, size, and class of pipe will be made at the contract unit price for that kind, size, and class of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe complete in place.

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(Use with Either Option) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

(44-3)





INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 46TILE DRAINS FOR LAND DRAINAGE1. Applicability.

Construction Specification 46 is applicable to the installation of all drain tile for land drainage.

2. Material Specifications.

The following material specifications are complementary to Construction Specification 46.

- a. Clay Tile and Clay Pipe: Specification 544
- b. Concrete Irrigation or Drainage Pipe and Drain Tile:  
Specification 543

3. Items to be Included in Contract Specifications and Drawings.

- a. Line and grade.
- b. Kind, size and class of tile.
- c. Typical cross sections, including typical bedding details.
- d. Special fittings, appurtenances, etc.
- e. Maximum and minimum trench widths.
- f. Procedures to use where unstable soils are encountered.
- g. Typical pipe outlets.
- h. Details of appurtenances.
- i. Location and details of any special tile bedding requirements.
- j. Use of automatic backfillers.
- k. Location of required compacted backfill.
- l. Details of any special fittings.
- m. Type of joint required (including spacers where required).

- n. Type, kind and size of materials to be used to cover joint or pipe.
- o. Type of envelope or filter.
- p. Gradation of sand-gravel envelope or filter material.
- q. Directions for covering pipe with envelope or filter material.

4. Discussion of Options.

Options are included in Sections 4, 5, and 7. The options are self-explanatory.

CONSTRUCTION SPECIFICATION (GUIDE)46. TILE DRAINS FOR LAND DRAINAGE1. SCOPE

The work shall consist of furnishing and installing drain tile and necessary fittings and appurtenances.

2. MATERIALS

Unless otherwise specified, the drain tile and fittings shall conform to the requirements of Material Specification 544 or Material Specification 543, whichever is applicable.

3. EXCAVATION

Unless otherwise specified, excavation for and subsequent installation of each tile line shall begin at the outlet end and progress upstream.

The trench or excavation for the tile shall be constructed to the depths and cross sections shown on the drawings. The trench width may be increased above the top of the tile, at the option of the Contractor.

Trench shields, shoring and bracing, or other methods, necessary to safeguard the workmen and work, and to prevent damage to the existing improvements shall be furnished, placed, and subsequently removed by the Contractor.

4. PREPARING THE TILE BED

(Option 1) In stable soils the tile shall be firmly and uniformly bedded throughout its entire length to the specified depth and in the specified manner.

If the bottom of the trench does not provide a sufficiently stable or firm foundation for the drain tile, cradles for the tile (constructed of timber or fabricated lumber of a cleat-and-rail type construction), a sand-gravel mix or other approved materials shall be used to stabilize the bottom of the trench.

Drain tile shall not be laid on rock foundation. In the event that boulders, rocks or ledge rock or cemented materials that prevent satisfactory bedding are encountered at the required grade, the

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trench shall be excavated to a depth of at least six inches below grade and backfilled to grade with a sand-gravel mixture or other approved material. The bedding material shall be compacted and shaped to grade.

(Option 2) Tile shall be bedded as shown on the drawings or as specified in Section 10.

## 5. LAYING TILE AND JOINT COVERING

(Option 1) Gaps between tile ordinarily shall be from one-eighth inch to one-quarter inch between tile in clay, clay loam and cohesive soils; and with tight fit in sandy soils and on lines to conduct water but not intended to provide underdrainage.

Where tile is laid with the width of opening exceeding the limits stated above in non-cohesive silts, and in fine and medium sands, the joint shall be covered with a permanent type material such as coal tar pitch treated roofing paper, fiber glass sheet or mat, or plastic sheet.

Where the gap between tile on the outer edge of a curved tile line exceeds the recommended gap for the type of soil encountered, it shall be covered with tile bats (broken tile) or covering material as described above. The tile may be chipped and fitted to secure the required joint opening.

The ends and inside surfaces of all tile shall be kept clean during laying. All earth or other extraneous material in the tile shall be removed before laying the next tile. At the end of each day's work and when laying has been temporarily suspended, the inlet end shall be blocked so that earth or other extraneous materials will not enter the tile. The upper end of each tile line shall be blocked with permanent type materials on completion of the line.

(Option 2) Tile shall be laid and joints shall be covered in the manner shown on the drawings or as specified in Section 10.

## 6. CONNECTIONS

Lateral connections will be made with manufactured junctions comparable in strength with the specified tile unless otherwise specified.

Where existing tile lines not shown on the drawings are crossed, they shall be bridged across the new trench or they shall be connected into the new tile lines, as directed by the Engineer.

7. BLINDING OR FILTER MATERIAL

(Option 1) As soon as the tile are placed, they shall be blinded by covering with friable topsoil to a depth of at least 6 inches. Material used for blinding shall not be frozen and shall contain no stones large enough to damage the tile or a specific size if specified. Sandy and other non-cohesive soils shall not be used for blinding unless the joints are covered. All tile placed during any day shall be blinded by the end of that day's work.

(Option 2) Tile shall be covered with sand and gravel meeting gradation, quality, quantities, and dimensions and installed as shown on the drawings or as specified in Section 10. Material used for blinding shall not be frozen and all tile placed during any day shall be blinded by the end of the day's work.

(Option 3) Unless otherwise specified, tile shall be covered with material from the trench.

8. BACKFILLING

The backfilling of the trench shall be completed as rapidly as consistent with the soil conditions.

Automatic backfilling machines may be used only when approved by the Engineer. Backfill shall extend above the ground surface and be well rounded over the trench.

Unless otherwise specified, where drain tile are laid under roads and at other designated locations shown on the drawings, the backfill shall be placed in successive layers of not more than six inches and each layer shall be tamped before the next layer is placed.

9. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the quantity of each kind, size and class of tile will be determined to the nearest foot of length along the centerline of the installed tile. Payment for each kind, size, and class of tile will be made at the contract unit price for that kind, size, and class of tile. Such payment will constitute full compensation for furnishing, transporting and installing the tile, including excavation, shoring, backfill and all fittings, appurtenances and other items necessary and incidental to the completion of the work. Payment for appurtenances listed separately in the bid schedule will

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be made at the contract unit prices for the sizes and types of appurtenances listed.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 10 of this specification.

(46-4)

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 51CORRUGATED METAL PIPE CONDUIT1. Applicability.

Construction Specification 51 is applicable to the installation of all types of corrugated metal pipe conduits.

2. Material Specifications.

The following specifications are complementary to Construction Specification 51:

a. Corrugated Iron or Steel Pipe.

Specification 551

b. Corrugated Aluminum Pipe.

Specification 552

3. Items to be Included in Contract Specifications and Drawings.

- a. Line and grade of the conduit.
- b. Details of the pipe bedding including description and grading limits of the bedding material.
- c. Details of wall fittings, joints and other special pipe fittings.
- d. Details of struts or ties.
- e. Pay limits or actual limits for excavation and backfill, if required.
- f. Applicable material specifications.
- g. Class, series, shape, size, length and gage of pipe.
- h. Type of couplings, if other than standard.
- i. Close riveting or double riveting, if required.



- j. Type of pipe coating, if required.
- k. Methods of measurement and payment if the standard specification includes more than one method.
- 1. Backfill requirements. Compaction requirements should be equal to requirements for the adjacent embankment for principal spillways or similar installations.

4. Discussion of Options.

Section 7, Measurement and Payment

- (1) The options are self-explanatory.
- (2) Two or more options may be included as numbered methods in standard specifications. However, in any single specification, the methods should be limited to either combinations of Options 1, 3, and 5 or combinations of Options 2, 4, and 6. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

All Methods. The following provisions apply to all methods of measurement and payment.

CONSTRUCTION SPECIFICATION (GUIDE)51. CORRUGATED METAL PIPE CONDUITS1. SCOPE

The work shall consist of furnishing and placing circular, arched or elliptical corrugated metal pipe and the necessary fittings.

2. MATERIALS

Pipe and fittings shall conform to the requirements of Material Specification 551 or Material Specification 552, whichever is specified.

3. LAYING AND BEDDING THE PIPE

Unless otherwise specified, the pipe shall be installed in accordance with the manufacturer's recommendations. The pipe shall be laid with the outside laps of circumferential joints pointing upstream and with longitudinal laps at the sides at about the vertical midheight of the pipe. Field welding of corrugated galvanized iron or steel pipe will not be permitted. Unless otherwise specified, the pipe sections shall be joined with standard coupling bands. The pipe shall be firmly and uniformly bedded throughout its entire length to the depth and in the manner specified on the drawings.

Perforated pipe shall be laid with the perforations down and oriented symmetrically about a vertical center line. Perforations shall be clear of any obstructions at the time the pipe is laid.

The pipe shall be loaded sufficiently during backfilling around the sides to prevent its being lifted from the bedding.

4. STRUTTING

When required, struts or horizontal ties shall be installed in the manner specified on the drawings. Struts and ties shall remain in place until the backfill has been placed to a height of 5 feet above the top of the pipe, or has been completed if the finished height is less than 5 feet above the top of the pipe, at which time they shall be removed by the Contractor.

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5. HANDLING THE PIPE

The Contractor shall furnish such equipment as is necessary to place the pipe without damaging the pipe or coatings. The pipe shall be transported and handled in such a manner as to prevent bruising, scaling or breaking of the spelter coating or bituminous coating.

6. REPAIR OF DAMAGED COATINGS

Any damage to the zinc coating shall be repaired by thoroughly wire brushing the damaged area, removing all loose and cracked coating, removing all dirt and greasy material with solvent, and painting with two coats of zinc dust-zinc oxide primer conforming to the requirements of Federal Specification TT-P-641, Type III. If the coating is damaged in any individual area larger than 12 square inches, or if more than 0.2 percent of a total surface area of a length of pipe is damaged, the length will be rejected.

Breaks or scuffs in bituminous coatings that are less than 36 square inches in area shall be repaired by the application of two coats of hot asphaltic paint or a coating of cold-applied bituminous mastic. The repair coating shall be at least 0.05 inches thick after hardening and shall bond securely and permanently to the pipe. The material shall meet the physical requirements for bituminous coatings contained in the references cited in Material Specifications 551 and 552. Whenever individual breaks exceed 36 square inches in area or when the total area of breaks exceeds 0.5 percent of the total surface area of the pipe, the pipe will be rejected.

Bituminous coating damaged by welding of coated pipe or pipe fittings shall be repaired as specified in this section for breaks and scuffs in bituminous coatings.

7. MEASUREMENT AND PAYMENT

(Option 1) For items of work for which specific unit prices are established in the contract, the quantity of each type, class, size and gage of pipe will be determined to the nearest 0.1 foot by measurement of the laid length of pipe along the centerline of the pipe. Payment for each type, class, size and gage of pipe will be made at the contract unit price for that type, class, size and gage of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe and fittings and all other items necessary and incidental to the completion of the work.

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(Option 2) For items of work for which specific unit prices are established in the contract, the quantity of each type, class, size and gage of pipe will be determined as the sum of the nominal laying lengths of the pipe sections and fittings used. Payment for each type, class, size and gage of pipe will be made at the contract unit price for that type, class, size and gage of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe and fittings and all other items necessary and incidental to the completion of the work.

(Option 3) For items of work for which specific unit prices are established in the contract, the quantity of each type, class, size and gage of pipe will be determined to the nearest 0.1 foot by measurement of the laid length of pipe along the centerline of the pipe. Payment for each type, class, size and gage of pipe will be made at the contract unit price for that type, class, size and gage of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe and fittings and all other items necessary and incidental to the completion of the work except items designated as "special fittings." Payment for special fittings will be made at the contract lump sum price for special fittings (CMP).

(Option 4) For items of work for which specific unit prices are established in the contract, the quantity of each type, class, size and gage of pipe will be determined as the sum of the nominal laying lengths of the pipe sections and fittings used. Payment for each type, class, size and gage of pipe will be made at the contract unit price for that type, class, size and gage of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe and fittings and all other items necessary and incidental to the completion of the work except items designated as "special fittings." Payment for special fittings will be made at the contract lump sum price for special fittings (CMP).

(Option 5) For items of work for which specific unit prices are established in the contract, the quantity of each type, class, size and gage of pipe will be determined to the nearest 0.1 foot by measurement of the laid length of pipe along the centerline of the pipe. Payment for each type, class, size and gage of pipe will be made at the contract unit price for that type, class, size and gage of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe, including the necessary fittings and all other items necessary and incidental to the completion of the work except the special



fittings and appurtenances listed separately in the bid schedule. Payment for each special fitting and appurtenance will be made at the contract unit price for that type and size of fitting or appurtenance.

(Option 6) For items of work for which specific unit prices are established in the contract, the quantity of each type, class, size and gage of pipe will be determined as the sum of the nominal laying lengths of the pipe sections used. Payment for each type, class, size and gage of pipe will be made at the contract price for that type, class, size and gage of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe, including the necessary fittings and all other items necessary and incidental to the completion of the work except the special fittings and appurtenances listed separately in the bid schedule. Payment for each special fitting and appurtenance will be made at the contract unit price for that type and size of fitting or appurtenance.

(Use with All Options) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 8 of this specification.

INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 52STEEL PIPE CONDUITS1. Applicability.

Construction Specification 52 is applicable to the installation of buried steel pipe conduits for the conveyance of water.

2. Material Specifications.

Material Specifications 553 and 581 are complementary to Construction Specification 52.

3. Items to be Included in Contract Specifications and Drawings.

- a. Line and grade of the conduit.
- b. Details of the bedding, including description and grading limits of the bedding material.
- c. Excavation and backfill requirements, if applicable.
- d. Pay limits or actual limits for excavation and backfill, if required.
- e. Kind of pipe. Include name, type, grade, finish, weight class, and wall thickness as required. (See appropriate reference specifications.)
- f. Size of pipe.
- g. Length of pipe.
- h. Type of protective coating, if required. (Refer to AWWA Standard C203 and Construction Specification 82 for detailed information.)
- i. Type of joint and details of special joints.
- j. Details of wall fittings and other special fittings and appurtenances.
- k. Watertightness or pressure test requirements, if applicable.

4. Discussion of Options.

Section 8, Measurement and Payment

The options are self-explanatory.

Both options may be included as numbered methods in standard specifications. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

Both Methods. The following provisions apply to both methods of measurement and payment.

CONSTRUCTION SPECIFICATION (GUIDE)52. STEEL PIPE CONDUITS1. SCOPE

The work shall consist of furnishing and installing steel pipe complete with the fittings and appurtenances specified on the drawings.

2. MATERIALS

Steel pipe and fittings shall conform to the requirements of Material Specification 553.

Unless otherwise specified, special fittings and appurtenances shall be of the same materials as the pipe.

Welding electrodes shall conform to the requirements of Material Specification 581.

3. LAYING AND BEDDING THE PIPE

Pipe shall be laid to the line and grade shown on the drawings. Unless otherwise specified, the pipe shall be installed in accordance with the manufacturer's recommendations. The pipe shall be firmly and uniformly bedded throughout its entire length to the depth and in the manner specified on the drawings.

The pipe shall be loaded sufficiently during backfilling around the sides to prevent its being lifted from the bedding.

4. JOINTS

Pipe joints shall conform to the details shown on the drawings and shall be sound and watertight at the pressures specified.

Welding and welded joints shall conform to the welding procedure details and the requirements for repair of welds of AWWA Standard C206 for Field Welding of Steel Water Pipe Joints (AWS D7.0). Field welding shall be done in such a way as to avoid burning the protective coating on the pipe except in the immediate vicinity of the weld.

The ends of pipe to be connected with mechanical couplings shall be machined so as to allow coupling the pipe sections without

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damaging or displacing the gaskets and to insure uniform end separation of the pipes. Machined ends of the pipe that receive the coupling sleeves shall be free from dents, gouges, rust, scale, or protective coating (except coal tar-epoxy paint). The pipe and couplings shall be assembled with continuous rubber ring gaskets conforming to the dimensions and tolerances recommended by the pipe manufacturer. Coupling followers shall be drawn up evenly to insure uniform pressure on the gaskets.

#### 5. FIELD COATING AND WRAPPING

When coal tar enamel coated pipe is specified, joints and couplings shall be primed and coated in the manner specified in AWWA Standard C203, Section 4. Joints and couplings shall be primed, coated, and wrapped where wrapped pipe is used. The use of coal tar tapes, applied in compliance with the manufacturer's instructions, is acceptable for coating joints and couplings if the resulting coating is equivalent in durability and watertightness to the coating on the pipe.

When it is specified that the pipe be coated with coal tar-epoxy paint, couplings shall be coated with coal tar-epoxy paint prior to assembly. Field application of coal tar-epoxy paint will be limited to touchup required to repair damage that occurs during assembly.

#### 6. HANDLING THE PIPE

The Contractor shall furnish such equipment as is necessary to place the pipe without damaging the pipe or coating. Coated pipe shall be handled in the manner specified in AWWA Standard C203, Section 4.

#### 7. MEASUREMENT AND PAYMENT

(Option 1) For items of work for which specific unit prices are established in the contract, the quantity of each type and size of pipe will be determined to the nearest 0.1 foot by measurement of the laid length of pipe along the centerline of the pipe. Payment for each type and size of pipe will be made at the contract unit price for that type and size of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe, including the necessary fittings and all other items necessary and incidental to the completion of the work.

ends of the pipe shall be plugged and braced to prevent movement, and backfill around the pipe between joints shall be placed as required to prevent movement. All joints and connections shall be completely exposed for visual inspection during the test.

If the amount of water loss exceeds the limit specified, the leaks shall be repaired and the conduit shall be retested as described above. The procedure shall be repeated until the amount of water loss is within the specified limit.

#### 8. MEASUREMENT AND PAYMENT

(Option 1) For items of work for which specific unit prices are established in the contract, the quantity of each type and size of pipe will be determined to the nearest 0.1 foot by measurement of the laid length of pipe along the centerline of the pipe. Payment for each type and size of pipe will be made at the contract unit price for that type and size of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe, including the necessary fittings and all other items necessary and incidental to the completion of the work.

(Option 2) For items of work for which specific unit prices are established in the contract, the quantity of each type and size of pipe will be determined to the nearest 0.1 foot by measurement of the laid length of pipe along the centerline of the pipe. Payment for each type and size of pipe will be made at the contract unit price for that type and size of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe, complete in place, including the necessary fittings and all other items necessary and incidental to the completion of the work except the special fittings and appurtenances listed separately in the bid schedule. Payment for each special fitting and appurtenance will be made at the contract unit price for that type and size of fitting or appurtenance.

(Use with Either Option) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 9 of this specification.

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 61LOOSE ROCK RIPRAP1. Applicability.

Construction Specification 61 is applicable to equipment-placed or hand-placed loose rock riprap, filter layers and bedding.

2. Material Specifications.

Material Specifications 521 and 523 are complementary to Construction Specification 61.

3. Items to be Included in Contract Specifications and Drawings.

- a. Complete plans and cross-sections of the required riprap.
- b. Type of placement (equipment- or hand-placed).
- c. Pay limits, where applicable.
- d. Class of subgrade fill, where applicable.
- e. Foundation preparation requirements, if any.
- f. Gradation requirements for materials.
- g. Screening, selection or other processing requirements, to insure obtaining rock of the required quality and grading.
- h. Sources of materials, if the sources are to be specified. When sources are designated in the contract, the available quantity and the quality of usable material at each source must be determined beforehand, by geologic investigations and (1) adequate sampling and testing or (2) specific case history which establishes the quality by satisfactory performance under comparable conditions of use and exposure.
- i. Methods of measurement and payment if the standard specification includes more than one method.



4. Discussion of Options.

Section 7, Measurement and Payment.

- (1) Option 1 is intended for use where filter material or bedding is a minor item and payment for it is to be included in the payment for riprap.
- (2) Options 2, 3, and 4 provide various means of measurement and are intended for use where filter material or bedding, if any, is to be paid for as a separate item.
- (3) Two or more options may be included as numbered methods in standard specifications. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

All Methods. The following provisions apply to all methods of measurement and payment.

CONSTRUCTION SPECIFICATION (GUIDE)61. LOOSE ROCK RIPRAP1. SCOPE

The work shall consist of the construction of loose rock riprap revetments and blankets, including filter layers or bedding where specified.

2. MATERIALS

Rock for loose rock riprap shall conform to the requirements of Material Specification 523 or, if so specified, shall be obtained from designated sources.

Rock from designated sources shall be excavated, selected and handled as necessary to meet the quality and grading requirements in Section 8 of this specification. The rock shall conform to the specified grading limits when installed in the riprap.

Filter material shall conform to the requirements of Material Specification 521 unless otherwise specified.

Bedding shall be obtained from the designated sources and shall be selected to meet the quality and grading requirements in Section 8 of this specification.

At least 30 days prior to delivery of material from other than designated sources, the Contractor shall notify the Contracting Officer in writing of the sources from which he intends to obtain the material. The Contractor shall provide the Engineer free access to the sources for the purpose of obtaining samples for testing.

3. SUBGRADE PREPARATION

The subgrade surfaces on which the riprap or bedding course is to be placed shall be cut or filled and graded to the lines and grades shown on the drawings. When fill to subgrade lines is required, it shall consist of approved materials and shall conform to the requirements of the specified class of fill.

Riprap shall not be placed until the foundation preparation is completed and the subgrade surfaces have been inspected and approved by the Engineer.

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4. EQUIPMENT-PLACED ROCK RIPRAP

The rock shall be placed by equipment on the surfaces and to the depths specified. The riprap shall be constructed to the full course thickness in one operation and in such a manner as to avoid serious displacement of the underlying materials. The rock shall be delivered and placed in a manner that will insure that the riprap in place shall be reasonably homogeneous with the larger rocks uniformly distributed and firmly in contact one to another with the smaller rocks and spalls filling the voids between the larger rocks.

Riprap shall be placed in a manner to prevent damage to structures. Hand placing will be required to the extent necessary to prevent damage to the permanent works.

5. HAND-PLACED RIPRAP

The rock shall be placed by hand on the surfaces and to the depths specified. It shall be securely bedded with the larger rocks firmly in contact one to another. Spaces between the larger rocks shall be filled with smaller rocks and spalls. Smaller rocks shall not be grouped as a substitute for larger rock. Flat slab rock shall be laid on edge.

6. FILTER LAYERS OR BEDDING

When the drawings specify filter layers or bedding beneath riprap, the filter or bedding material shall be spread uniformly on the prepared subgrade surfaces to the depth specified. Compaction of filter layers or bedding will not be required, but the surface of such layers shall be finished reasonably free of mounds, dips or windrows.

7. MEASUREMENT AND PAYMENT

(Option 1) For items of work for which specific unit prices are established in the contract, the volume of each type of riprap, including filter layers and bedding, will be measured within the specified limits and computed to the nearest cubic yard by the method of average cross-sectional end areas. Payment for each type of riprap, including filter layers and bedding, will be made at the contract unit price for that type of riprap. Such payment will be considered full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the riprap, filter layers and bedding.

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8. MEASUREMENT AND PAYMENT

(Option 1) For items of work for which specific unit prices are established in the contract, the volume of each type of riprap, including filter layers and bedding, will be measured within the specified limits and computed to the nearest cubic yard by the method of average cross-sectional end areas. Payment for each type of riprap, including filter layers and bedding, will be made at the contract unit price for that type of riprap. Such payment will be considered full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the riprap, filter layers and bedding.

(Option 2) For items of work for which specific unit prices are established in the contract, the volume of each type of riprap and the volume of each type of filter layer or bedding will be measured within the specified limits and computed to the nearest cubic yard by the method of average cross-sectional end areas. Payment for each type of riprap will be made at the contract unit price for that type of riprap. Payment for each type of filter or bedding will be made at the contract unit price for that type of filter or bedding. Such payment will be considered full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the riprap, filter layers and bedding.

(Option 3) For items of work for which specific unit prices are established in the contract, the quantity of each type of riprap placed within the specified limits will be measured to the nearest ton by actual weight, and the volume of each type of filter layer or bedding will be measured within the specified limits and computed to the nearest cubic yard by the method of average cross-sectional end areas. For each load of rock placed as specified, the Contractor shall furnish to the Engineer a statement-of-delivery ticket showing the weight, to the nearest 0.1 ton, of rock in the load.

Payment for each type of riprap will be made at the contract unit price for that type of riprap. Payment for each type of filter or bedding will be made at the contract unit price for that type of filter or bedding. Such payment will be considered full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the riprap, filter layers and bedding.

(Option 4) For items of work for which specific unit prices are established in the contract, the quality of each type of riprap placed within the specified limits will be measured to the nearest ton by actual weight, and the volume of each type of filter

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material or bedding delivered and placed within the specified limits will be measured to the nearest cubic yard by measurement of the hauling equipment. For each load of material placed as specified, the Contractor shall furnish to the Engineer a statement-of-delivery ticket showing the weight, to the nearest 0.1 ton, of rock in the load; or the volume, to the nearest 0.1 cubic yard, of filter material or bedding in the load.

Payment for each type of riprap will be made at the contract unit price for that type of riprap. Payment for each type of filter or bedding will be made at the contract unit price for that type of filter or bedding. Such payment will be considered full compensation for all labor, materials, equipment and all other items necessary and incidental to completion of the riprap, filter layers and bedding.

(Use with All Options) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 9 of this specification.

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 71WATER CONTROL GATES1. Applicability.

Construction Specification 71 is applicable to the installation of gates for purposes of water control, including slide gates, flap gates and radial gates.

2. Material Specifications.

Material Specifications 571, 572, 573, 574, 575, 576 and 577 are complementary to Construction Specification 71. Table A-71 is a guide to selection of metal water control gates. When fabricated wooden gates are required for special applications, a material specification tailored to the specific job is usually more appropriate.

3. Items to be Included in Contract Specifications and Drawings.

- a. Plans, elevations and sections showing location of gates and type and size of openings.
- b. Types of gates and applicable material specifications.
- c. Class of gate (seating and unseating heads expressed as a numerical symbol). Example: Class 40-10.
- d. Type of frame (flat, spigot, flange, flange with spigot) and details of the method of attaching the gate to the structure or pipe. Include thimble details, when required, together with designation of type of thimble (Types: E, F, C, L, Flange and Bell, or Flange and Flare.)
- e. Special gate requirements (self-contained, non-rising stem, flush-bottom opening, etc.); include material requirements for fabricated metal gates if other than steel is required.
- f. Type and capacity of gate stems, hoists, lifts, stem guides, stem housings, couplings, sleeves and other appurtenances.

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- g. Paint systems to be used in shop and field painting.  
(Refer to Construction Specification 82.)

4. Discussion of Options.

No options are included.

TABLE A-71. GUIDE TO SELECTION OF METAL WATER CONTROL GATES

TYPE OF GATE SATISFACTORY FOR EXPOSURE CONDITION						
TYPE OF GATE	APPLICATION	FREQUENCY OF USE	FRESH WATER OR SLIGHT POLLUTION	MODERATE POLLUTION		EXTREME POLLUTION, SEA WATER, BRACKISH WATER
				MAINLY DOMESTIC SEWAGE (AND AGRICULTURAL)	MAINLY INDUSTRIAL WASTE	
Slide	Drainage gates; Canal headgates	Frequent	MLS-1, MLS-2, MMS-1	MHS-2	MHS-2	MHS-3
		Infrequent	MMS-1, MHS-1			
	Sediment pool drainage gate	Infrequent	MHS-1 MMS-2	MHS-2	MHS-2	MHS-3
		Reservoir water supply intake gates	Frequent	MMS-2 MHS-1	MHS-2	MHS-2
			Infrequent	MHS-1 MMS-2	MHS-3	MHS-3
		Flap	Accessible gravity outlets		MLF-1 MMF-1	MHF-2
	MMF-1 MHF-1			MHF-2	MHF-2	MHF-3
Pump outlets, not subject to slamming			MMF-1 MHF-1	MHF-2	MHF-2	MHF-3
	Pump outlets, subject to slamming			MHF-1R	MHF-2R	MHF-2R





CONSTRUCTION SPECIFICATION (GUIDE)71. WATER CONTROL GATES1. SCOPE

The work shall consist of furnishing and installing water control gates including gate stems, hoists, lifts and other appurtenances.

2. MATERIALS

The gates furnishes shall conform to the requirements specified in Section 8 or on the drawings. All gates shall be furnished complete with hoisting equipment and other specified appurtenances.

3. INSTALLING GATES

The Contractor shall install the gates in a manner that will prevent leakage around the seats and binding of the gates during operation.

Surfaces of metal against which concrete will be placed shall be free from oil, grease, loose mill scale, loose paint, surface rust, and other debris or objectionable coatings.

Anchor bolts, thimbles and spigot frames shall be secured in true position in the forms and held in alignment during the placement of concrete.

Concrete surfaces against which rubber seals will bear or against which flat frames or plates are to be installed shall be finished to provide a smooth and uniform contact surface.

When a flat frame is installed against concrete, a layer of bedding mortar shall be placed between the frame and the concrete.

When a gate is attached to a wall thimble, a mastic or resilient gasket shall be applied between the gate frame and the thimble, in accordance with the recommendation of the gate manufacturer.

For radial gates, wall plates, sills and pin brackets shall be adjusted and fastened by grouting and bolting after the gates have been completely assembled in place.

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4. INSTALLING HOISTS AND LIFTS

Gate stems, stem guides and gate lifts shall be carefully aligned so that the stem shall be parallel to the guide bars or angles on the gate frame after installation.

Radial gate hoists shall be installed in correct alignment with relation to the gate shaft.

5. RADIAL GATE SEALS

The rubber seals on radial gates shall be installed so that the seals contact the walls or wall plates throughout their entire length when the gates are closed.

6. OPERATIONAL TESTS

After the gate and hoist (or lift) have been installed, they shall be cleaned, lubricated and otherwise serviced by the Contractor in accordance with the manufacturer's instructions. The Contractor shall test the gate and hoist by operating the system several times throughout its full range of operation. He shall make any changes and adjustments necessary to insure satisfactory operation of the gate system.

7. MEASUREMENT AND PAYMENT

The number of each type, size and class of gate will be counted. Payment for furnishing and installing each type, size and class of gate shall be made at the contract unit price for that type, size and class of gate. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work including furnishing and installing anchor bolts and all specified appurtenances and fittings.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and items to which they are made subsidiary are identified in Section 8 of this specification.

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 81METAL FABRICATION AND INSTALLATION1. Applicability.

Construction Specification 81 is applicable to the construction of items of metal work not covered by other specifications. It is applicable to such items as trash guards, anti-vortex hoods and baffles, flashboard guides, buildings for pumping stations or gate control stations, and similar structures or parts. It is not applicable to the installation of concrete reinforcing steel, water control gates, fences, wells, piles or pipe conduits.

2. Material Specifications.

Material Specifications 581 and 582 and Construction Specification 82 are complementary to Construction Specification 81.

3. Items to be Included in Contract Specifications and Drawings.

- a. Detailed drawings as necessary to show the dimensions and method of fabricating and erecting the item or structure.
- b. For aluminum, the alloy to be used in the work if other than specified in Material Specification 581. Alloys specified for use should be limited to those for which ASCE Specifications for Structures of Aluminum Alloy are available. Such specifications are published in Section A of the Aluminum Construction Manual of The Aluminum Association.
- c. Type of steel if other than structural quality. Use "commercial" or "merchant" quality only for small parts where strength is not important. Examples: Non-critical angles and other shapes less than 3 inches in maximum dimension of section; shear plates for construction joints in concrete; small trash rack parts.
- d. Details of connections showing sizes and number of bolts; sizes, kinds and dimensions of welds; sizes and number of rivets.



- e. Designation of items to be galvanized or painted and designation of paint systems to be used.
- f. Ordering data listed in the material specifications, as appropriate, including such items as:
  - (1) Type, kind, size and length of bolts.
  - (2) Class, grade, condition and finish of castings.
  - (3) Type, composition, hardness, size and form of other materials.
- g. Methods of measurement and payment, if the standard specification includes more than one method.

4. Discussion of Options.

Section 6, Measurement and Payment.

- (1) Option 1 is intended for use when the metalwork is a minor portion of the contract and consists largely of items that would normally be fabricated by the prime contractor.
- (2) Option 2 is intended for use when the metalwork is a significant portion of the contract.
- (3) Option 3 is intended for use when the metalwork includes individual items of significant scope or complexity or which would usually be procured from a subcontractor.
- (4) Two or more options may be included as numbered methods in standard specifications. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

All Methods. The following provisions apply to all methods of measurement any payment.

CONSTRUCTION SPECIFICATION (GUIDE)81. METAL FABRICATION AND INSTALLATION1. SCOPE

The work shall consist of furnishing, fabricating and erecting metalwork, including the metal parts of composite structures.

2. MATERIALS

Unless otherwise specified, materials shall conform to the requirements of Material Specification 581. Steel shall be structural quality unless otherwise specified. Castings shall be thoroughly cleaned and subjected to careful inspection before installation. Finished surfaces shall be smooth and true to assure proper fit. Galvanizing shall conform to the requirements of Material Specification 582.

3. FABRICATION

Fabrication of structural steel shall conform to the requirements of Section 1.23 of the "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings (Riveted, Bolted and Arc-Welded Construction)," American Institute of Steel Construction.

Fabrication of structural aluminum shall conform to the requirements in the Aluminum Construction Manual, "Specifications for Aluminum Structures," Section 6 and Section 7, The Aluminum Association, November 1967.

4. ERECTION

The frame of metal structures shall be carried up true and plumb. Temporary bracing shall be placed wherever necessary to resist all loads to which the structure may be subjected, including those applied by the installation and operation of equipment. Such bracing shall be left in place as long as may be necessary for safety.

As erection progresses the work shall be securely bolted up, or welded, to resist all dead load, wind and erection stresses. The Contractor shall furnish such fitting up bolts, nuts and washers as may be required.

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No riveting or welding shall be done until as much of the structure as will be stiffened thereby has been properly aligned.

Rivets driven in the field shall be heated and driven with the same care as those driven in the shop.

All field welding shall be done in conformance to the requirements for shop fabrication, except those that expressly apply to shop conditions only.

Galvanized items shall not be cut, welded or drilled after the zinc coating is applied.

#### 5. PROTECTIVE COATINGS

Items specified to be galvanized shall be completely fabricated for field assembly before the application of the zinc coatings.

Items specified to be painted shall be painted in conformance to the requirements of Construction Specification 82 for the specified paint systems.

#### 6. MEASUREMENT AND PAYMENT

(Option 1) The work will not be measured. Payment for metal fabrication and installation will be made at the contract lump sum price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work, including connectors and appurtenances such as rivets, bolts, nuts, pins, studs, washers, hangers and weld metal.

(Option 2) The weight of metal installed complete in place shall be determined to the nearest pound. Unless otherwise provided, the weight of metal shall be computed by the method specified in Section 3 of the "Code of Standard Practice for Steel Buildings and Bridges," American Institute of Steel Construction, except that the following unit weights shall also be used, as appropriate, as the basis of computation:

<u>Material</u>	<u>Unit Weight</u> <u>Pounds per Cubic Foot</u>
Aluminum alloy	173.0
Bronze or copper alloy	536.0
Iron, malleable	470.0
Iron, wrought	487.0

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Payment for furnishing, fabricating and installing metalwork will be made at the contract unit price for the specified types of metals. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work.

(Option 3) The work will not be measured. Payment for furnishing, fabricating and installing each item of metalwork will be made at the contract price for that item. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work, including connectors and appurtenances such as rivets, bolts, nuts, pins, studs, washers, hangers and weld metal.

(Use with All Options) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.





INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 82CLEANING AND PAINTING METALWORK1. Applicability.

Construction Specification 82 is applicable to the painting of metalwork including structural metal, water control gates, piping, pumps and other machinery.

The durability of paint films on metal depends upon the exposure condition, the types of paints used, the thickness of the coating and the method of preparing the metal surface prior to the application of paint. To a large extent the type of paint required is dictated by the exposure condition and the required surface preparation is dictated by the type of paint to be used. Therefore, to simplify the specification of cleaning and painting methods, nine standard "paint systems" have been established and defined in the construction specification. Each paint system specifies the method of surface preparation, the type of paint and the number of coats or minimum dry paint film thickness required.

The paint systems are not equivalent optional methods. Each paint system is designed for a particular exposure condition or to produce a particular finished appearance or both. The criteria for selection of the appropriate paint system are summarized in Table A of these instructions.

Where only a small amount of painting is to be done, which is not required for protection, use a simple note on the drawings rather than Construction Specification 82.

2. Material Specifications.

Material Specification 583, Coal Tar Epoxy Paint, is complementary to Construction Specification 82. References to Federal Specifications covering other types of paints are included in the construction specification.

3. Items to be Included in Contract Specifications and Drawings.

- a. Indicate by notes the surfaces and items to be painted.
- b. Designate the paint system (by letter) to be used for cleaning and painting each indicated item. If all metal work is to be painted by the same paint system, one standard note to that effect will be sufficient.

- c. Instructions for painting when special conditions require painting by systems or methods not covered by the standard specifications.

4. Discussion of Options.

No options are included.

TABLE A-82. PAINT SYSTEMS FOR METALWORK

Paint System	Exposure Condition	Typical Items
A	Continuous or frequent submergence in water.	Trash guards, slide gates, flap gates, stoplog guides, metal stoplogs, etc.
B	Normal exterior atmospheric exposure in very <u>humid</u> climate or exposure where sunlight is <u>predominant</u> and occasional submergence in water is probable.	Exterior surfaces of buildings, overflow, drains, gutters, scuppers, piping subject to severe condensation, etc.
C	Normal <u>exterior</u> atmospheric exposure in arid to moderately humid climate or interior exposure where sunlight is predominant.	Interior or exterior surfaces of buildings, piping, pumps and machinery above operating floor, gate control pedestals, cranes, bridge members, etc.
D	Normal exterior or <u>interior</u> atmospheric exposure where colors <u>other</u> than aluminum are required and high <u>gloss</u> is desired.	
E	Same as System D, but where <u>semi-gloss</u> is desired.	These systems are used for the repair or recoating of galvanized items.
F	Normal exterior or interior atmospheric exposure.	
G	Submergence in water.	



TABLE A-82 (continued)

Paint System	Exposure Condition	Typical Items
H	Continuous or frequent submergence in water or exposure in damp or humid locations and no exposure to sunlight.	Exterior surfaces of pumps below operating floor, under side of pump base plates, floats and control wells, etc.
I	Continuous or frequent submergence in fresh or salt water and intermittent exposure to sunlight. Intermittent exposure to extremes of temperature (between -30°F and 180°F). Exposure to dilute mineral acids or alkalies. Exposure to abrasive materials transported by water or wind. Contact with abrasive materials during placement of coated items.	Trash guards, water control gates, steel pipe, steel piling, stoplog guides, tanks, flumes, etc.

Note: When special protective coatings are required, the following references are recommended:

- (a) Paint Manual, Bureau of Reclamation, Department of Interior
- (b) Paint Manual, Engineering Manual, Civil Works and Military Construction, Part CXXXIV, Corps of Engineers, Department of the Army
- (c) American Water Works Association Specifications

CONSTRUCTION SPECIFICATION (GUIDE)82. CLEANING AND PAINTING METALWORK1. SCOPE

The work shall consist of cleaning metal surfaces and applying paints and protective coatings.

2. PAINTS

For the purposes of this specification paints shall be designated by types as defined below:

Type 1 paint shall conform to the requirements of Federal Specification TT-P-86, Type IV, Red Lead Base Paint.

Type 2 paint shall conform to the requirements of Federal Specification TT-P-86, Type II or Type III, Red Lead Base Paint.

Type 3 paint shall conform to the requirements of Federal Specification TT-P-86, Type I, Red Lead Base Paint.

Type 4 paint shall conform to the requirements of Federal Specification TT-P-636, Synthetic Primer.

Type 5 paint shall be prepared by mixing aluminum paste conforming to the requirements of Federal Specification TT-P-320, Type II, Class 2 with phenolic resin spar varnish conforming to the requirements of Federal Specification TT-V-119 at the rate of two pounds of aluminum paste per gallon of varnish. The paint shall be mixed at the time of use.

Type 6 paint shall be prepared by mixing aluminum paste conforming to Federal Specification TT-P-320, Type II, Class 2 with mixing varnish conforming to the requirements of Federal Specification TT-V-81, Type II, Class B (Class 2) at the rate of two pounds of aluminum paste per gallon of varnish. The paint shall be mixed at the time of use.

Type 7 paint shall conform to the requirements of Federal Specification TT-E-489, Class A, Alkyd Gloss Enamel.

Type 8 paint shall conform to the requirements of Federal Specification TT-E-529, Alkyd Semi-Gloss Enamel.

Type 9 paint shall conform to the requirements of Federal Specification TT-P-641, Type I or Type II, Zinc Dust-Zinc Oxide Primer.

Type 10 paint shall conform to the requirements of Federal Specification TT-P-641, Type III, Zinc Dust-Zinc Oxide Primer.

Type 11 paint shall conform to the requirements of Material Specification 583. The paint shall be mixed at the time of use.

Paints of Types 1, 2, 3, 5 and 6 may be thinned with mineral spirits as necessary for proper application but the amount of thinner used shall not exceed one pint per gallon of paint. Other paints may be thinned in accordance with the manufacturer's instructions only if such thinning is approved by the Engineer.

When tinting is required, it shall be accomplished by the addition of pigment-in-oil tinting colors conforming to the requirements of Federal Specification TT-P-381.

Mineral spirits shall conform to the requirements of Federal Specification TT-T-291, Grade 1, Light Thinner.

### 3. SURFACE PERPARATION

Surfaces to be painted shall be thoroughly cleaned prior to the application of the paint. For the purposes of this specification methods of surface preparation shall be designated as defined below:

Method 1 surface preparation shall consist of the removal of all grease and oil by means of steam cleaning or solvent cleaning methods and removal of all dirt, rust, mill scale and other coatings by means of sandblasting, grit blasting or pickling. The finished surface shall uniformly expose the base metal and shall present an etched, but not polished or peened, appearance. Not more than 5 percent of the surface may exhibit very light shadows, light streaks, or slight discolorations caused by rust stain, mill scale oxides, or slight, tight residues of paint or coating.

(82-2)



Method 2 surface preparation shall consist of the removal of all grease and oil by means of steam cleaning or solvent cleaning and the removal of all dirt, surface rust and loose scale by means of wire brushing, flame cleaning, use of rotary abrading tools or light sandblasting.

Method 3 surface preparation shall consist of the treatment of the surface with a dilute acid solution. The surface shall be thoroughly wetted with a dilute (about 5 percent strength) phosphoric acid solution. After the acid has dried, the surface shall be thoroughly rinsed with clear water and allowed to dry. Dirt, grease and oil shall be removed from the surface by solvent cleaning prior to the acid treatment.

Cleaning solvent shall be mineral spirits. Cleaning cloths and solvents shall be discarded before they become contaminated to the extent that a greasy film would remain on the surface being cleaned. The final cleaning and wiping shall be done with clean solvent and clean cloths. Grit blasting shall be accomplished using compressed air blast nozzles and grit made of steel, malleable iron or cast iron crushed shot. Abrasives used shall have a maximum particle size that will pass the No. 16 sieve (U. S. Standard) and a minimum size that will be retained on the No. 50 sieve (U. S. Standard). The equipment used for sandblasting shall be equipped with adequate separators and traps to insure that the compressed air shall be free of detrimental amounts of water and oil. Blast cleaned surfaces shall be brushed, blown or vacuum cleaned to remove any trace of blast products or abrasives prior to painting.

Surfaces that are not to be painted immediately after cleaning shall be treated with one brush coat of metal conditioner conforming to the requirements of Military Specification MIL-M-10578, except that surfaces cleaned by pickling in phosphoric acid solution shall not require such treatment.

Surfaces shall be thoroughly dry when paint is applied.

No field coats of paint shall be applied until the prepared surfaces have been inspected and approved by the Engineer.

#### 4. PAINT SYSTEMS

For the purposes of this specification, systems of preparing and painting metalwork will be designated as defined below:

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Paint System A shall consist of the preparation of the surfaces to be painted by Method 1 and the application of two priming coats of Type 1 paint and two or more top coats of Type 5 paint as necessary to provide a total dry paint film thickness of 6 mils.

Paint System B shall consist of the preparation of the surfaces to be painted by Method 1 and the application of one priming coat of Type 1 paint and two top coats of Type 5 paint.

Paint System C shall consist of the preparation of the surfaces to be painted by Method 2 and the application of one priming coat of Type 2, Type 3 or Type 4 paint and two top coats of Type 6 paint.

Paint System D shall consist of the preparation of the surfaces to be painted by Method 2 and the application of one priming coat of Type 2 paint and two top coats of Type 7 paint.

Paint System E shall consist of the preparation of the surfaces to be painted by Method 2 and the application of one priming coat of Type 2 paint and two top coats of Type 8 paint.

Paint System F shall consist of the preparation of the surfaces to be painted by Method 3 and the application of two coats of Type 9 paint.

Paint System G shall consist of the preparation of the surfaces to be painted by Method 3 and the application of two coats of Type 10 paint.

Paint System H shall consist of the preparation of the surfaces to be painted by Method 1 and the application of four or more coats of Type 1 paint as necessary to provide a total dry paint film thickness of 6 mils.

Paint System I shall consist of the preparation of the surfaces to be painted by Method 1 and the application of two or more coats of Type 11 paint as necessary to provide a total dry paint film thickness of at least 16 mils.

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## 5. APPLICATION OF PAINT

Surfaces shall be painted immediately after preparation (or within two days after preparation and treatment with metal conditioner) with at least one coat of the type of priming paint required by the specified paint system. Surfaces not required to be painted shall be protected against contamination and damage during the cleaning and painting operation.

Paints shall be thoroughly mixed at the time of application.

After erection or installation of the metalwork, all damage to shop applied coats shall be repaired and all bolts, nuts, welds and field rivet heads shall be cleaned and painted with one coat of the specified priming paint.

Except on surfaces accessible only to spray equipment, initial priming coats shall be applied by brush. All other coats may be applied by brush or spray. Each coat shall be applied in such a manner as to produce a paint film of uniform thickness with a rate of coverage within the limits recommended by the paint manufacturer.

The drying time between coats shall be as prescribed by the manufacturer of the paint but not less than that required for the paint film to dry through. The elapsed time between the application of the first and second prime coats of Paint System A shall not exceed 60 hours. In the application of Paint System I, if, for any reason, the first coat dries hard before the second coat is applied or the elapsed time between coats exceeds 48 hours, the method of application must be modified in any of the following ways: (1) the first coat must be wiped down with MIBK with the application of the second coat following the wipedown by not more than 6 feet; or (2) the first coat must be lightly brush blasted or given a fog coat of the paint before application of the full second coat; or (3) a special bonding additive supplied by the paint manufacturer must be mixed with the paint applied in the second coat.

The finished surface of each coat shall be free from runs, drops, ridges, laps or excessive brushmarks and shall present no variation in color, texture and finish.

The surface of each dried coat shall be cleaned as necessary before application of the next coat.

Except for Paint System I, the first coat of each two-coat system shall be tinted for contrast. The first coat of red-lead paint shall be tinted by the addition of 3 ounces per gallon of 1B

(82-5)

black pigment. The first coat of machinery paint shall be tinted off color with 3 ounces per gallon of a pigment suitable to the color of the paint.

#### 6. ATMOSHPERIC CONDITIONS

Paint shall not be applied when the temperature of the item to be painted or of the surrounding air is less than 50°F. For Paint System I, the temperature of the coated surface must be maintained at not less than 50°F for 6 hours after the application of each coat. Painting shall be done only when the humidity and temperature of the surrounding air and the temperature of the metal surfaces are such that evaporation rather than condensation will result during the period of time required for application and drying. Surfaces protected from adverse atmospheric conditions by special cover, heating or ventilation shall remain so protected until the paint is dry.

#### 7. TESTS

Acceptance of dry paint film thickness for Paint Systems A, H, and I will be based on the measurement of paint film thickness by means of an Elcometer or other suitable dry film thickness gage.

#### 8. PAYMENT

For items of work for which specific lump sum prices are established in the contract, payment for painting metalwork will be at the contract lump sum price. Such payment will constitute full compensation for furnishing, preparing and applying all materials and for the cleaning, painting and coating of metalwork including labor, tools, equipment and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 9 of this specification.



INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 83TIMBER FABRICATION AND INSTALLATION1. Applicability.

Construction Specification 83 is applicable to all types of timber construction (except pile driving or the use of round timber) that are normally entailed in Service operations. Supplementary specifications will be required for works of a special nature, such as bridges or buildings.

2. Material Specifications.

Material Specifications 584, 585, 582 and 581 and Construction Specification 84 are complementary to Construction Specification 83.

3. Items to be Included in Contract Specifications and Drawings.

- a. Plans and dimensions of all structural elements.
- b. Complete details of all connections including number, type and size of connectors; location of bolts, screws, pins; number, size and kind of nails or spikes if the design requires that these be specified; depth of embedment of screws and pins, etc.
- c. For lumber and timber, specify:
  - (1) Stress grade.
  - (2) Species according to standard commercial name.
  - (3) Heartwood requirements or other special requirements.
  - (4) Nominal size and dress requirements (rough or dressed).
  - (5) Preservative treatment, if required.  
(Refer to Federal Specification TT-W-571 for guidance to type of treatment.)
  - (6) Applicable grading rule, including the name of the agency that sponsors the rule (such as National Hardwood Lumber Association), the paragraph number and the year of issue.



d. For plywood, specify:

- (1) Number of plies, width and length of sheet.
- (2) Species or group according to PS 1-66.
- (3) Grade
- (4) Type (exterior, interior)
- (5) Finished thickness
- (6) Finish requirements (such as sanded or unsanded)

e. Designation of surfaces to be painted.

f. Special instructions concerning cutting of treated lumber or timber, if such operations are to be allowed.

4. Discussion of Options.

Section 6, Measurement and Payment.

- (1) Option 1 is intended for use in cases where the quantities of lumber and timber are large and the measurement of structural elements is feasible.
- (2) Option 2 is considered more appropriate for structures of moderate size.

Both options may be included as numbered methods in standard specifications. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

Both Methods. The following provisions apply to both methods of measurement and payment.

CONSTRUCTION SPECIFICATION (GUIDE)83. TIMBER FABRICATION AND INSTALLATION1. SCOPE

The work shall consist of the construction of timber structures and timber portions of composite structures.

2. MATERIALS

Structural timber and lumber shall conform to the requirements of Material Specification 584. Treated timber and lumber shall be impregnated with the specified type and quantity of preservative and in the manner specified in Material Specification 585.

Hardware, except cast iron, shall be galvanized as specified for iron and steel hardware in Material Specification 582. Unless otherwise specified, structural steel shapes, plates and rods shall not be galvanized. Nuts, driftbolts, dowels and screws shall be either wrought iron or medium steel.

Steel bolts shall conform to the requirements of ASTM Specification A 307. When galvanized or zinc-coated bolts are specified, the zinc coating shall conform to the requirements of ASTM Specification A 153; except that bolts 1/2 inch or less in diameter may be coated with electrodeposited zinc or cadmium coating conforming to the requirements of ASTM Specification A 164, Type RS, or ASTM Specification A 165, Type TS, unless otherwise specified.

Washers shall be ogee gray iron castings or malleable iron castings unless washers cut from medium steel or wrought iron plate are specified on the drawings. Cast washers shall have a thickness equal to the diameter of the bolt and a diameter equal to four times the thickness. For plate washers the thickness shall be equal to one-half the diameter of the bolt, and the sides of the square shall be equal to four times the diameter of the bolt. Holes in washers shall be not more than one-eighth inch greater in diameter than the bolt. Split ring connectors, tooth ring connectors and pressed steel shear plate connectors shall be manufactured from hot-rolled, low carbon steel conforming to the requirements of ASTM Designation A 273, Grade 1015. Malleable iron shear plate connectors and spike grid connectors shall be manufactured in conformance with the requirements of ASTM Designation A 47, Grade No. 35018. All connectors shall be of approved design and the type and size specified.

(83-1)

Structural shapes, rods and plates shall be structural steel conforming to the requirements of Material Specification 581. No welds will be permitted in truss rods or other main members of trusses or girders.

### 3. WORKMANSHIP

All framing shall be true and exact. Timber and lumber shall be accurately cut and assembled to a close fit and shall have even bearing over the entire contact surfaces. No open or shimmed joints will be accepted. Nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient cause for rejection of the work.

Holes for round driftpins and dowels shall be bored with a bit one-sixteenth inch smaller in diameter than that of the driftpin or dowel to be used. The diameter of holes for square driftpins or dowels shall be equal to one side of the driftpin or dowel. Holes for machine bolts and rods shall be bored with a bit of the same diameter as that of the bolt. Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

Washers shall be used in contact with all bolt heads and nuts that would otherwise be in contact with wood. Cast iron washers shall be used when the bolt will be in contact with earth. All nuts shall be checked or burred effectively with a pointed tool after being finally tightened.

Unless otherwise specified, surfacing, cutting and boring of timber and lumber shall be done before treatment. If cutting of treated timber and lumber is authorized, all cuts and abrasions shall be carefully trimmed and coated with not less than three brush coats of the same preservative used in the original treatment.

All recesses and holes cut or bored in treated timber and lumber shall be swabbed with not less than three coats of the same preservative used in the original treatment. After field treatment any unfilled holes shall be plugged with tightly fitting wooden plugs treated with the same preservative used in the original treatment.

(83-2)



#### 4. HANDLING AND STORING MATERIALS

All timber and lumber stored at the site of the work shall be neatly stacked on supports at least twelve inches above the ground surface and protected from the weather by suitable covering. Untreated material shall be so stacked and stripped as to permit free circulation of air between the tiers and courses. Treated timber shall be close-stacked. The ground underneath and in the vicinity of all stacks shall be cleared of weeds and rubbish. The use of cant hooks, peavies, or other pointed tools, except end hooks will not be permitted in the handling of structural timber or lumber. Treated timber shall be handled with rope slings or other methods that will prevent the breaking or bruising of outer fibers, or penetration of the surface in any manner.

#### 5. PAINTING

Except as otherwise specified, surfaces designated for painting shall be painted in accordance with Construction Specification 84.

#### 6. MEASUREMENT AND PAYMENT

(Option 1) The unit of measurement of lumber and timber will be the number of thousand feet board measure (MBM) of each type, size, species and grade of lumber and timber in place in the completed structure. The quantity of each type, size, species and grade will be computed from the nominal dimensions and actual lengths of the pieces in the completed structure and will not include waste timber used for erection purposes (such as falsework or temporary sheeting and bracing) or any portion of any pile or other round timber. The total quantity of lumber and timber in each type, size, species and grade will be computed to the nearest 0.01 MBM.

The unit of measurement of plywood will be the number of square feet of each type, species, grade and thickness in place in the completed structure.

Payment for each type, size, species and grade of lumber and timber will be made at the contract unit price for that type, size, species and grade. Payment for each type, species, grade and thickness of plywood will be made at the contract unit price for that type, species, grade and thickness. Such payment will be considered full compensation for all labor, equipment, transportation and materials and all other items necessary and incidental to the completion of the structure in place including hardware and accessories, paint and wood preservatives.

(83-3)

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(Option 2) No measurement of material quantities will be made. Payment for each structure, complete in place, will be made at the contract lump sum price for that structure. Such payment will be considered full compensation for all labor, transportation, equipment and materials and all other items necessary and incidental to the completion of the work.

(Use with Either Option) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

(83-4)

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 84PAINTING WOODWORK1. Applicability.

Construction Specification 84 is applicable only to the exterior painting of woodwork.

2. Material Specifications.

There are no material specifications complementary to Construction Specification 84.

3. Items to be Included in Contract Specifications and Drawings.

- a. Surfaces to be painted.
- b. Instructions for tinting if colors other than white are required.
- c. Paint to be used if other than specified in Section 2.
- d. Number of coats if other than specified in Section 4.

4. Discussion of Options.

No options are included.



CONSTRUCTION SPECIFICATION (GUIDE)84. PAINTING WOODWORK1. SCOPE

The work shall consist of cleaning and preparing wood surfaces and applying paints.

2. MATERIALS

Unless otherwise specified, painting materials shall meet the following requirements:

Exterior paint primer shall conform to the requirements of Federal Specification TT-P-25.

Exterior oil paint shall conform to the requirements of Federal Specification TT-P-102. Unless otherwise specified, the color shall be white. The second coat of exterior oil paint may be thinned with mineral spirits conforming to the requirements of Federal Specification TT-T-295 or with pure gum turpentine, but the amount of thinner used shall not exceed one pint per gallon of paint.

When tinting is required it shall be accomplished by the addition of pigment-in-oil tinting colors conforming to the requirements of Federal Specification TT-P-381.

3. SURFACE PREPARATION

All surfaces to be painted shall be thoroughly cleaned prior to the application of paint. Pitch pockets and knots shall be scraped and sealed with a shellac varnish conforming to the requirements of Federal Specification TT-S-300. Previously painted surfaces shall be scraped and brushed to remove any checked or blistered paint and all excess chalk.

4. APPLICATION OF PAINT

Surfaces shall be clean and dry when paint is applied. No paint shall be applied until the prepared surfaces have been inspected and approved by the Engineer.

(84-1)



Surfaces of new wood shall be painted with one brush coat of exterior priming paint and two brush coats of exterior oil paint.

Paints shall be thoroughly mixed at the time of application.

Each coat shall be applied in such a manner as to produce a paint film of uniform thickness with a finished surface free from runs, drops, ridges, laps or excessive brushmarks. The drying time between coats shall be as prescribed by the manufacturer of the paint but not less than that required for the paint film to dry through.

The surface of each dried coat shall be cleaned as necessary before application of the next coat.

The first coat of exterior oil paint shall be tinted off color by the addition of 3 ounces of an appropriate tinting color per gallon of paint.

5. ATMOSPHERIC CONDITIONS

Paint shall not be applied when the temperature of the wood surface or of the surrounding air is less than 45°F nor when atmospheric conditions result in condensation of moisture on the surface to be painted. Surfaces protected from adverse atmospheric conditions by special cover, heating or ventilation shall remain so protected until the paint is dry.

6. PAYMENT

For items of work for which specific lump sum prices are established in the contract, payment for painting woodwork will be made at the contract lump sum price and such payment will be full compensation for furnishing, preparing and applying all materials and for the cleaning and painting of woodwork including labor, tools, equipment and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

(84-2)

INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 91CHAIN LINK FENCE1. Applicability.

Construction Specification 91 is applicable to the installation of chain link fences.

2. Material Specifications.

No material specifications are complementary to Construction Specification 91.

3. Supplemental Items to be Included in Contract Specifications and Drawings.

- a. Plan showing the location and extent of fences including location of gates, corners, pull posts and end points.
- b. Dimensions of the fence including post spacing, clearance from ground and height of fence.
- c. Details of posts and assemblies.
  - (1) Types of post (U, H, round or square).
  - (2) Line post detail showing height of post, depth of embedment.
  - (3) Details of corner post assembly, pull post, end post, including embedment, top rail connections, tension wire detail, braces, trusses, etc.
  - (4) Special anchor requirements, if any.
- d. Dimensions of gate openings (clear opening between inside faces of the gate posts).
- e. Type of gates (swing or sliding).
- f. Required appurtenances such as locks, barbed wire arms, barbed wire, post tops.

4. Discussion of Options.

Under "Measurement and Payment" Option 1 is intended for use when gates are a minor part of the work item. Option 2 is intended for use when gates form a substantial part of the work item or when gates must be installed in existing fences.

Both options may be included as numbered methods in standard specifications. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

Both Methods. The following provisions apply to both methods of measurement and payment.

CONSTRUCTION SPECIFICATION (GUIDE)91. CHAIN LINK FENCE1. SCOPE

The work shall consist of furnishing and installing chain link fencing complete with all posts, braces, gates and all other appurtenances.

2. MATERIALS

Fence posts, gates and accessories shall conform to the requirements of Federal Specification RR-F-183.

Fencing; chain link fabric shall conform to the requirements of Federal Specification RR-F-191 for the type and grade specified. Unless otherwise specified, the fencing shall be Class 1, Coating A, B, or C, 2-inch mesh, 9 gage.

Barbed wire shall conform to the requirements of Federal Specification RR-F-221 for 4-point, 12½-gage barbed wire with Class 2 zinc coating.

3. INSTALLING FENCE POSTS

Unless otherwise specified, line posts shall be placed at intervals of 10 feet measured from center to center of adjacent posts. In determining the post spacing, measurement will be made parallel with the ground surface.

Posts will be set in concrete backfill in the manner shown on the drawings.

Posts set in the tops of concrete walls shall be grouted into preformed holes to a depth of 12 inches.

All corner posts, end posts, gate posts, and pull posts shall be embedded, braced and trussed as shown on the drawings.

4. INSTALLING WIRE FABRIC

Fencing fabric shall not be stretched until at least 4 days after the posts are grouted into walls or 14 days after the posts are set in the concrete backfill.

(91-1)



Fencing shall be installed on the side of the posts designated on the drawings.

The fabric shall be stretched taut and securely fastened, by means of tie clips, to the posts at intervals not exceeding 15 inches and to the top rails or tension wires at intervals not exceeding 2 feet. Care shall be taken to equalize the tension on each side of each post.

Barbed wire shall be installed as shown on the drawings and shall be pulled taut and fastened to each post with tie wires or metal tie clips.

5. MEASUREMENT AND PAYMENT

(Option 1) The length of fence will be measured to the nearest 0.1 foot along the fence, including gates. Payment will be made at the contract unit price for the specified height of fence. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work.

(Option 2) The length of fence will be measured to the nearest 0.1 foot along the fence, excluding gate openings. Payment will be made at the contract unit price for the specified height of fence. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work except furnishing, fabricating and installing gates. Payment for furnishing, fabricating and installing each type and size of gate will be made at the contract unit price for that type and size of gate.

(Use with Either Option) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 6 of this specification.

(91-2)

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INSTRUCTIONS FOR USE OF CONSTRUCTION SPECIFICATION 92FARM FIELD FENCES1. Applicability.

Construction Specification 92 is applicable to the installation of farm field fences of the barbed wire, woven wire or wire netting types.

2. Material Specifications.

Material Specification 591 is complementary to Construction Specification 92.

3. Items to be Included in Contract Specifications and Drawings.

- a. Plan showing the location and extent of fences including location of gates, corners and end points.
- b. Dimensions of the fence including post spacing, clearance from ground and height of fence.
- c. Details of concrete posts, if required.
- d. Details of posts and assemblies.
  - (1) Type of posts.
  - (2) Line post detail showing height of post, depth of embedment.
  - (3) Details of end panel assembly, pull post assembly and corner assembly including types of posts, types of backfill, types and dimensions of braces, gages of tension wires and details of fastening of tension wires to posts.
  - (4) Special anchor requirements for posts at crossings over depressions or waterways.
- e. Details of gates.

(The details listed in b, c, d, and e may often be shown on a standard drawing developed for use in all projects within a given area.)

f. Type and kind of fencing.

- (1) For barbed wire fencing specify gage of wire, zinc-coated or uncoated, shape and spacing of barbs and the number of points per barb.
- (2) For woven wire fencing specify the design number (as given in Federal Specification RR-F-221).
- (3) For wire netting specify the height of netting, size of mesh and gage of wire.

g. Species of wood posts.

h. Preservative treatment of wood posts and braces as applicable.

i. Protective coating (painted or zinc-coated) for steel posts and braces.

4. Discussion of Options.

Section 10, Measurement and Payment.

- (1) Option 1 is intended for use when gates are simple and of the field fabricated type.
- (2) Option 2 is intended for use when gates must be shop fabricated or when gates must be installed in existing fences.

Both options may be included as numbered methods in standard specifications. If numbered methods are used, insert the following paragraph before the last paragraph in the section:

Both Methods. The following provisions apply to both methods of measurement and payment.

CONSTRUCTION SPECIFICATION (GUIDE)92. FARM FIELD FENCES1. SCOPE

The work shall consist of furnishing and installing farm field fences, including gates and fittings.

2. MATERIALS

Materials for farm field fences shall conform to the requirements of Material Specification 591. All wooden posts shall be of the same species.

3. SETTING POSTS

Concrete or wood posts shall be set in holes and backfilled with earth except where otherwise specified. Steel posts shall be driven unless otherwise specified.

Posts holes shall be at least 6 inches larger than the diameter or side dimension of the posts.

Earth backfill around posts shall be thoroughly tamped in layers not thicker than 4 inches and shall completely fill the post hole up to the ground surface. Concrete backfill around posts shall be rodded into place in layers not thicker than 12 inches and shall completely fill the post hole up to the ground surface. Backfill, either earth or concrete, shall be crowned up around posts at the ground surface.

No stress shall be applied to posts set in concrete until at least 24 hours after the concrete has set.

4. CORNER ASSEMBLY

Unless otherwise specified, corner assemblies shall be installed at all points where the fence alignment changes 15 degrees or more.

5. END PANELS

End panels shall be built at gates and fence ends.

6. PULL POST ASSEMBLY

Pull post assemblies shall be installed at the following locations:

(92-1)

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- a. In straight fence sections, at intervals of no more than 660 feet.
- b. At any point where the vertical angle described by two adjacent reaches of wire is upward and exceeds 10 degrees (except as provided in Section 9 of this specification).
- c. At the beginning and end of each curve.

#### 7. ATTACHING FENCING TO POSTS

The fencing shall be stretched and attached to posts as follows:

- a. The fencing shall be placed on the side of the post opposite the area being protected, except on curves.
- b. The fencing shall be placed on the outside of curves.
- c. The fencing shall be fastened to each end post, corner post and pull post by wrapping each horizontal strand around the post and tying it back on itself with not less than three tightly wound wraps.
- d. The fencing shall be fastened to wooden line posts by means of staples. Woven wire fencing shall be attached at alternate horizontal strands. Each strand of barbed wire shall be attached to each post. Staples shall be driven diagonally with the grain of the wood and at a slight downward angle and shall not be driven so tightly as to bind the wire against the post.
- e. The fencing shall be fastened to steel or concrete line posts with either two turns of 14 gage galvanized steel or iron wire or the post manufacturer's special wire clips.
- f. Wire shall be spliced by means of a Western Union splice having not less than 8 wraps of each end about the other. All wraps shall be tightly wound and closely spaced.

#### 8. STAYS

Stays shall be attached to the fencing in a manner to insure maintenance of the proper spacing of the fence wire strands.

#### 9. CROSSINGS AT DEPRESSIONS AND WATERCOURSES

Where fencing is installed across small depressions or watercourses, either of the following methods of installation shall be used:

(92-2)

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- a. If the fence wire is installed parallel to the ground surface, the line posts subject to upward pull shall be anchored by means of extra embedment or by special anchors as detailed on the drawings.
- b. If the wire fence is installed with the top wire straight and parallel to the ground surface on either side of the depression, extra length posts shall be used to allow normal post embedment. Unless otherwise specified, excess space between the bottom of the fence and the ground shall be closed with extra strands of barbed wire.

10. MEASUREMENT AND PAYMENT

(Option 1) The length of each type and kind of fence will be measured to the nearest foot along the profile of the fence, including gate openings. Payment for each type and kind of fence will be made at the contract unit price for that type and kind of fence. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work including fabricating and installing gates.

(Option 2) The length of each type and kind of fence will be measured to the nearest foot along the profile of the fence, excluding gate openings. Payment for each type and kind of fence will be made at the contract unit price for that type and kind of fence. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work, except fabricating and installing gates. Payment for each type and size of gate will be made at the contract price each for fabricating and installing that type and size of gate.

(Use with Either Option) Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 11 of this specification.



CHAPTER 3

GUIDE MATERIAL SPECIFICATIONS





MATERIAL SPECIFICATION511. STEEL PILES1. SCOPE

This specification covers the type and quality of steel piles.

2. BEARING PILES

Steel bearing piles shall be structural steel H-piles conforming to the requirements of ASTM Specification A 36.

The required length of pile may be fabricated by butt-welding shorter lengths of pile stock. Unless otherwise specified, the cross section of each pile shall be constant throughout its length. The axis of the pile shall be straight and the number of welded joints in the length of the pile shall be as few as practicable. Pieces below the top piece shall be not less than 10 feet in length.

3. SHEET PILES

Steel sheet piles shall conform to the requirements of ASTM Specification A 328.

Sheet piles shall be the standard interlocking type having positive interlocks, effective in both longitudinal and transverse directions, that are continuous throughout the length of the pile. Fabrication of piles from shorter lengths of pile stock will not be allowed.

(511-1)

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MATERIAL SPECIFICATION512. WOOD PILES1. SCOPE

This specification covers the quality of wood piles.

2. QUALITY OF PILES

The piles shall conform to the requirements of Federal Specification MM-P-371 for the specified types and classes of piles.

3. TREATMENT

Type II piles shall be treated with the specified type and amount of preservative and in conformance to the requirements of Material Specification 585.

4. MARKING

Each Type II pile delivered to the job site shall be marked as specified in Material Specification 585.

No marking is required for Type I piles.





MATERIAL SPECIFICATION513. PRECAST CONCRETE PILES1. SCOPE

This specification covers the quality of precast concrete piles.

2. GENERAL REQUIREMENTS

The piles shall conform to the details shown on the drawings. The piles shall be cast of portland cement concrete mixed, placed, and cured by the methods specified in Construction Specification 31. except as amended in this specification. The finished piles shall be true to line with smooth surfaces free from stone pockets, honeycombs or other defects.

3. CLASS OF CONCRETE

Unless otherwise specified, the concrete shall be Class 4000.

4. REINFORCEMENT

Reinforcement shall conform to the requirements of Construction Specification 34.

5. FORMS

Forms shall be built of plywood, metal or dressed lumber and shall have one inch chamfer strips at all corners. They shall be mortar-tight, true to line and supported in a manner to prevent deformation or settlement during placement of the concrete. They shall be so designed as to be removable without damaging the completed piles.

6. PLACING CONCRETE

The concrete shall be placed in each pile in one continuous operation. The concrete shall be compacted and worked into the forms and around the reinforcement by the methods and in the manner specified in Construction Specification 31.

7. CURING

The piles shall be cured for a period of not less than 14 days by one of the methods specified in Construction Specification 31.

(513-1)

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Test cylinders taken for the purpose of determining when the piles may be subjected to handling stresses shall be cured by the same method, at the same location and under the same conditions as those applied to the piles.

The steam curing process may be used in lieu of moist curing or membrane curing. The piles shall be cured in place on the casting bed by the introduction of steam into a steam-tight housing that completely encloses the casting bed. The first application of steam shall be applied after the concrete has undergone initial set but in no case sooner than 2 hours after the concrete is placed unless a set-retarding admixture is used in the mix. When a set-retarding admixture is used in the mix, the first application of steam shall be applied no sooner than 4 hours after the concrete is placed. Moist curing methods shall be applied during the interval between the placement of the concrete and the application of the steam.

The steam shall be at 100 percent relative humidity and shall not be applied directly on the concrete. During application of the steam, the ambient air temperature within the housing shall be increased at a rate of not more than 40°F per hour until the maximum temperature is reached. The temperature within the housing shall be maintained between 140°F and 160°F until the concrete has reached the specified strength. In discontinuing the application of the steam, the ambient air temperature within the housing shall be decreased at a rate of not more than 40°F per hour until the temperature within the housing is not more than 20°F above the ambient air temperature outside the housing.

The concrete shall not be exposed to temperature below freezing for at least 6 days after placement.

8. REMOVING FORMS

Side forms shall remain in place at least 24 hours.

9. HANDLING AND STORING PILES

The Contractor shall handle and store piles by methods that will not cause spalling, cracking or other damage to them. The Contractor shall furnish such bridles, slings and other equipment as are necessary.

(513-2)

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Piles shall not be moved until the tests indicate a compressive strength of at least 80 percent of the design 28-day compressive strength. They shall be neither transported nor driven until the field cured test cylinders indicate a compressive strength at least equal to the design 28-day compressive strength.

Piles that are cracked, spalled or otherwise damaged during handling will be rejected.

(513-3)

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MATERIAL SPECIFICATION514. CAST-IN-PLACE CONCRETE PILES WITH SHELLS1. SCOPE

This specification covers the quality of piles formed by driving shells to the required bearing, leaving the shells permanently in place, and filling them with concrete.

2. GENERAL REQUIREMENTS

The piles may have constant diameter or may be tapered. In diameter, a tapered pile shall increase uniformly, or in uniformly sized and spaced steps, from bottom to top. Unless otherwise specified, the average diameter of each pile shall be not less than 11 inches. The minimum tip diameter of a tapered pile shall be eight inches.

3. SHELL

The shell shall be made of reinforced concrete or steel. It shall have sufficient strength and rigidity to prevent its distortion during driving or after driving by soil or water pressures or pressures caused by the driving of adjacent piles. It shall be sufficiently watertight to exclude water during placement of concrete. Driven shells shall be clean and free of water before reinforcing steel or concrete is placed.

4. REINFORCEMENT

When internal reinforcement is specified, it shall conform to the details on the drawings and to the requirements of Construction Specification 34.

5. CONCRETE

Concrete shall not be placed in any pile until the driven shell, with the reinforcement in place, has been inspected and approved by the Engineer.

Unless otherwise specified, the concrete: (1) shall conform to the requirements of Construction Specification 31 and shall be Class 4000; (2) shall be placed in each pile in one continuous operation; and (3) shall be placed and consolidated into the shell in conformance to the requirements of Construction Specification 31.

(514-1)

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MATERIAL SPECIFICATION521. AGGREGATES FOR DRAIN FILL AND FILTERS1. SCOPE

This specification covers the quality of mineral aggregates for the construction of drain fill and filters.

2. QUALITY

Drain fill and filter aggregates shall be sand, gravel or crushed stone or mixtures thereof. They shall be composed of clean, hard, durable mineral particles free from organic matter, clay balls, soft particles or other substances that would interfere with their free-draining properties. Not more than 15 percent, by weight, shall be flat, elongated particles.

Unless otherwise specified, not more than 5 percent of the material finer than a No. 4 sieve shall be crushed limestone.

When tested for soundness according to ASTM Method C 88, the aggregates shall have a weighted average loss in five cycles of not more than 12 percent when sodium sulfate is used or 18 percent when magnesium sulfate is used.

3. GRADING

Drain fill and filter aggregates shall conform to the specified grading limits after being placed in the work, and after being compacted if compaction is specified. Grading shall be determined by ASTM Method C 136, but the percentage of material finer than a No. 200 sieve shall be not more than 3 percent when determined by ASTM Method C 117.

4. STORING AND HANDLING

Drain fill and filter aggregates shall be stored and handled by methods that prevent segregation of particle sizes or contamination by mixing with other materials.

(521-1)





MATERIAL SPECIFICATION522. AGGREGATE FOR PORTLAND CEMENT CONCRETE1. SCOPE

This specification covers the quality of fine aggregate and coarse aggregate for use in the manufacture of portland cement concrete.

2. QUALITY

Aggregate shall conform to the requirements of ASTM Specification C-33 for the specified sizes. Aggregates that fail to meet any requirement may be accepted only when: (1) the specified alternate conditions of acceptance can be proved prior to the use of the aggregates on the job and within a period of time such that no work under the contract will be delayed by the requirements of such proof; or, (2) the specification for concrete expressly contains a provision of special mix requirements to compensate for the effects of the deficiencies.

3. REACTIVITY WITH ALKALIES

The potential reactivity of aggregates with the alkalis in cement shall be evaluated by petrographic examination and, where applicable, the chemical method of test, ASTM Designation C 289, or by the results of previous tests or service records of concrete made from similar aggregates from the same source. The standards for evaluating potential reactivity shall be as described in ASTM Specification C 33, Appendix A1.

Aggregates indicated by any of the above to be potentially reactive shall not be used, except under one of the following conditions:

- a. Applicable test results of mortar bar tests, made according to ASTM Method C 227, are available which indicate an expansion of less than 0.10 percent at six months in mortar bars made with cement containing not less than 0.8 percent alkalis expressed as sodium oxide; or
- b. Concrete made from similar aggregates from the same source has been demonstrated to be sound after 3 years or more of service under conditions of exposure to moisture and weather similar to those anticipated for the concrete under these specifications.

(522-1)

Aggregates indicated to be potentially reactive, but within acceptable limits as determined by mortar bar test results or service records, shall be used only with "low alkali" cement, containing less than 0.60 percent alkalies expressed as sodium oxide.

4. STORING AND HANDLING

Aggregate of each class and size shall be stored and handled by methods that prevent segregation of particle sizes or contamination by intermixing with other materials.

(522-2)

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MATERIAL SPECIFICATION523. ROCK FOR RIPRAP1. SCOPE

This specification covers the quality of rock to be used in the construction of rock riprap.

2. QUALITY

Individual rock fragments shall be dense, sound and free from cracks, seams and other defects conducive to accelerated weathering. The rock fragments shall be angular to subrounded in shape. The least dimension of an individual rock fragment shall be not less than one-third the greatest dimension of the fragment.

Except as provided below, the rock shall have the following properties:

- a. Bulk specific gravity (saturated surface-dry basis) not less than 2.5.
- b. Absorption not more than 2 percent.
- c. Soundness: Weight loss in 5 cycles not more than 10 percent when sodium sulfate is used or 15 percent when magnesium sulfate is used.

The bulk specific gravity and absorption shall be determined by ASTM Method C 127. The test for soundness shall be performed according to the procedure for ledge rock in Federal Specification SS-R-406c, Method 203.01.

Rock that fails to meet the requirements stated in a, b, and c above, may be accepted only if similar rock from the same source has been demonstrated to be sound after 5 years or more of service under conditions of weather, wetting and drying, and erosive forces similar to those anticipated for the rock to be installed under this specification.

3. GRADING

The rock shall conform to the specified grading limits after it has been placed in the riprap.

(523-1)





MATERIAL SPECIFICATION531. PORTLAND CEMENT1. SCOPE

This specification covers the quality of portland cements.

2. QUALITY

Portland cement shall conform to the requirements of ASTM Specification C 150 for the specified types of cement, except that, whenever Type I portland cement is specified, portland blast furnace slag cement conforming to the requirements of ASTM Specification C 595 may be used in lieu thereof.

If air-entraining cement is to be used, the Contractor shall furnish the manufacturer's written statement giving the source, amount and brand name of the air-entraining addition.

3. STORAGE AT THE CONSTRUCTION SITE

Cement shall be stored in such a manner as to be protected from weather, dampness or other destructive agencies. Cement that is partially hydrated or otherwise damaged will be rejected.

(531-1)

NEH 8/1/72 (Notice 20-33)



MATERIAL SPECIFICATION532. AIR-ENTRAINING ADMIXTURES  
(FOR CONCRETE)1. SCOPE

This specification covers the quality of air-entraining admixtures for concrete.

2. QUALITY

Air-entraining admixtures shall conform to the requirements of ASTM Specification C 260, except that the relative durability factor in the freezing and thawing test shall be not less than 95.

(532-1)

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## MATERIAL SPECIFICATION

533. WATER-REDUCING AND SET-RETARDING ADMIXTURES  
FOR PORTLAND CEMENT CONCRETE1. SCOPE

This specification covers the quality of water-retarding and set-retarding admixtures for portland cement concrete.

2. QUALITY

Water-reducing and set-retarding admixtures shall conform to the requirements of ASTM Specification C 494, except that resistance to freezing and thawing shall be determined in all cases, and the minimum relative durability factor shall be 95.

3. TYPES

Admixtures shall be Type A, Water-Reducing or Type D, Water-Reducing and Retarding, as defined in ASTM Specification C 494.

4. PERFORMANCE IN THE JOB MIX

When added in the manner and amount recommended by the manufacturer to the concrete used on the job, with no change in the cement content or proportions of the aggregates, admixtures shall have the following effects:

Type A or Type D: The water content at the required slump shall be at least 5 percent less with the admixture than without. The air content shall remain within the range specified, but shall not exceed 8 percent in any case.

Type D: The time of initial setting, determined as prescribed in ASTM C 494, shall be from 1 to 3 hours longer with the admixture than without.

(533-1)

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MATERIAL SPECIFICATION534. CURING COMPOUND (FOR CONCRETE)1. SCOPE

This specification covers the quality of liquid membrane-forming compounds suitable for spraying on concrete surfaces to retard the loss of water during the curing process.

2. QUALITY

The curing compound shall meet the requirements of ASTM Specification C 309.

Unless otherwise specified the compound shall be Type 2.

3. DELIVERY AND STORAGE

All curing compound shall be delivered to the site of the work in the original container bearing the name of the manufacturer and the brand name. The compound shall be stored in a manner to prevent damage to the containers and to protect water-emulsion types from freezing.

(534-1)

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MATERIAL SPECIFICATION535. PREFORMED EXPANSION JOINT FILLER1. SCOPE

This specification covers the quality of preformed expansion joint fillers for concrete.

2. QUALITY

Preformed expansion joint filler shall conform to the requirements of ASTM Specification D 1752, Type I, Type II or Type III, unless bituminous type is specified. Bituminous type preformed expansion joint filler shall conform to the requirements of ASTM Specification D 994.

(535-1)

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MATERIAL SPECIFICATION536. SEALING COMPOUND FOR JOINTS IN CONCRETE AND CONCRETE PIPE1. SCOPE

This specification covers the quality of sealing compound for filling joints in concrete pipe and concrete structures.

2. TYPE

The compound shall be a cold-application mastic, single component or multiple component type.

The single component type shall be a ready-mixed nondrying compound furnished in troweling consistency or in preformed rope or strip form.

The multiple component type shall be composed of two or more substances that are to be mixed prior to application.

3. QUALITY

Sealing compound shall conform to the requirements of one of the following specifications:

ASTM Specification D 1850; Concrete Joint Sealer, Cold-Application Type. Penetration, determined as specified in ASTM D 1850, shall be not greater than 120.

Federal Specification SS-S-00210; Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.

Federal Specification TT-S-227; Sealing Compound; Rubber Base, Two Component (For Calking, Sealing and Glazing in Building Construction), Type II.

The compound shall be capable of being applied at a temperature of 70°F and shall be of such nature that it will adhere to dry, dust free concrete when applied either directly or over a suitable primer. After curing it shall be a resilient, adhesive material that is capable of filling joints and firm enough to prevent the entry of subsequently placed concrete or of earth during the bedding, cradling or backfilling operations.

(536-1)

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4. COMPOSITION AND PROPERTIES

The compound, if used for pipe having rubber gaskets, shall have a composition such that it will not cause deterioration of the rubber gaskets.

(536-2)

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MATERIAL SPECIFICATION537. NON-METALLIC WATERSTOPS1. SCOPE

This specification covers non-metallic waterstops for use in joints of concrete structures.

2. CLASSIFICATION

- a. Classes. Non-metallic waterstops shall be of the following classes, as specified:

Class I shall be made of either natural or synthetic rubber.

Class II shall be made of vinyl chloride polymer or copolymer.

- b. Types. Non-metallic waterstops may be either split or solid and shall conform to the following types, as specified (see Figure 1):

Type A shall have ribbed anchor flanges and a smooth web. Flanges may be of uniform thickness or may have either a converging or a diverging taper toward the edges.

Type B shall have ribbed anchor flanges and a smooth web containing a hollow tubular center bulb having: (1) a wall thickness equal to at least one-half the web thickness and (2) the inside diameter (D) specified in the contract. Flanges may be of uniform thickness or may have either a converging or a diverging taper toward the edges.

Type C shall have a single, circular, bulb-type anchor flange at each edge and a smooth web.

Type D shall have a single, circular, bulb-type anchor flange at each edge and a smooth web containing a hollow tubular center bulb having: (1) a wall thickness equal to at least one-half the thickness of the web and (2) the inside diameter (D) specified in the contract.

(537-1)

Type E shall have ribbed anchor flanges and a web molded or extruded in the form of a round or U-shaped bulb of the dimensions specified in the contract. The web bulb shall be connected at the open end of the "U" by a thin membrane (having a thickness of not less than 1/64-inch or more than 1/5 the web thickness) designed to: (1) prevent infiltration of wet concrete into the bulb and (2) tear when expansion of the joint occurs. Flanges may be of uniform thickness or may have either a converging or a diverging taper toward the edges. Auxilliary positioning or nailing flanges may be provided so long as they do not interfere with the functioning of the web bulb.

Type F shall have ribbed anchor flanges with at least two extra heavy ribs (designed to resist displacement of the waterstop during placement of concrete) on each flange and a smooth web having a positioning or nailing flange attached at the center.

Type G shall be of special design conforming to the details shown on the drawings.

- c. Sizes. Waterstops of Types A through F shall be of the sizes listed herein, as specified (see Table 1). Type G waterstops shall have the dimensions shown on the drawings.

### 3. PHYSICAL REQUIREMENTS

The extruded or molded materials shall exhibit the properties specified herein when tested by the methods specified in Section 4 of this specification.

#### a. Class I Waterstops

- (1) The hardness (Shore A durometer) shall be not less than 60.
- (2) The specific gravity shall be not more than 1.2.
- (3) The tensile strength shall be not less than 2500 pounds per square inch.
- (4) The ultimate elongation shall be not less than 450 percent.

(537-2)

- (5) The compression set shall be not more than 30 percent.
- (6) The water absorption (by weight) shall be not more than 5 percent.
- (7) The decrease in tensile strength and ultimate elongation after aging shall be not more than 20 percent.
- (8) There shall be no sign of failure due to brittleness at a temperature of minus 35°F.

b. Class II Waterstops

- (1) The hardness (Shore A durometer) shall be not less than 60.
- (2) The specific gravity shall be not more than 1.4.
- (3) The tensile strength shall be not less than 1400 pounds per square inch.
- (4) The ultimate elongation of the web shall be not less than 280 percent and that of the flanges shall be not less than 200 percent.
- (5) The water absorption (by weight) shall be not more than one percent.
- (6) There shall be no sign of failure due to flange brittleness at a temperature of 0°F. nor of web brittleness at a temperature of minus 35°F.
- (7) The decrease in either tensile strength or ultimate elongation after accelerated extraction shall be not greater than 15 percent.
- (8) As a result of the effects of alkalies:
  - (a) After immersion for 7 days, the sample shall exhibit no loss of weight and not more than 0.25 percent increase in weight, and the hardness (Shore A) of the treated sample shall differ from that of the untreated sample by not more than plus 5 points or minus 5 points.

(537-3)



- (b) After immersion for 30 days, the sample shall exhibit no loss of weight and not more than 0.40 percent increase in weight, and the dimensions of the treated sample shall not differ from those of the untreated sample by more than one percent.

#### 4. TEST METHODS

Testing shall be done by the methods cited herein. All cited test methods are included in Federal Test Method Standard No. 601.

- a. Hardness shall be determined by Method 3021.
- b. Specific gravity shall be determined by Method 14011.
- c. Tensile strength shall be determined by Method 4111.
- d. Ultimate elongation shall be determined by Method 4121.
- e. Compression set shall be determined by Method 3311.
- f. Water absorption shall be determined by Method 6631.
- g. Tensile strength and ultimate elongation after aging shall be determined by Method 7111.
- h. Brittleness shall be determined by Method 5311.
- i. Accelerated extraction shall be accomplished by Method 6111 under the following conditions:
  - (1) Samples shall be not less than 1/16-inch nor more than 1/8-inch in thickness;
  - (2) The immersion medium shall be a solution made by dissolving 5 grams of chemically pure sodium hydroxide and 5 grams of chemically pure potassium hydroxide in one liter of distilled water;
  - (3) The samples shall be immersed in the medium for 14 days at a temperature of  $145^{\circ} \pm 5^{\circ}\text{F}$ ;
  - (4) During the immersion period, air shall be gently bubbled through the medium from a 1/4-inch glass tube at a rate of about one bubble per second;

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- (5) Fresh medium shall be substituted every day;
  - (6) Samples need not be dipped in acetone.
- j. The effects of alkalies shall be determined by Method 6251 under the following conditions:
- (1) Samples shall be not more than 1/4-inch in thickness;
  - (2) The immersion medium shall be as described in (i), above;
  - (3) Fresh medium shall be substituted every 7 days.
  - (4) The samples shall be immersed in the medium for a period of 30 days;
  - (5) Samples need not be dipped in acetone.

5. CONDITION

Waterstops shall be extruded or molded in such a manner that the material is dense and homogeneous throughout and free from voids, tears, thins, indentations, or other imperfections. Unless otherwise specified, waterstops shall be symmetrical in shape and uniform in dimensions and shall be furnished in continuous strips at least 50 feet long. Factory splices shall have a tensile strength equal to at least one-half that of the unspliced section.

6. PACKAGING AND STORING

Waterstops shall be package and stored by methods that will protect them from prolonged exposure to direct sunlight or excessive heat.

TABLE 1. SIZES OF WATERSTOPS

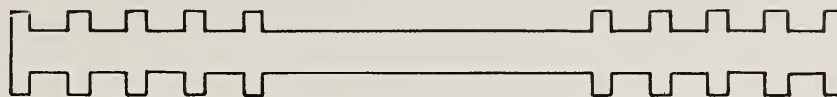
<u>Size Designation</u>	<u>Web Thickness (T) (Inches)</u>	<u>Width (W) (Inches)</u>
1	1/16	5 1/4
2	3/32	3 3/4
3	3/32	4
4	3/32	5 1/4
5	3/32	6
6	1/8	4
7	1/8	5 1/4
8	1/8	6
9	5/32	4
10	5/32	4 1/2
11	5/32	9
12	3/16	4
13	3/16	5
14	3/16	6
15	3/16	9
16	1/4	6
17	1/4	9
18	3/8	5
19	3/8	6
20	3/8	9
21	1/2	6
22	1/2	9
23	1/2	12

(537-6)

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FIGURE 1  
TYPES OF NON-METALLIC WATERSTOPS

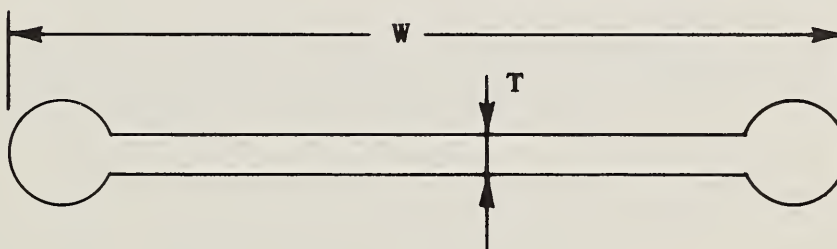
TYPE A



TYPE B



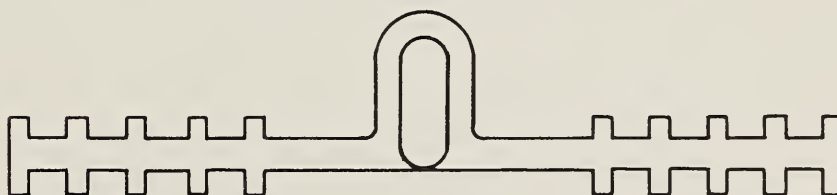
TYPE C



TYPE D



TYPE E



TYPE F



(537-7)

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MATERIAL SPECIFICATION538. METAL WATERSTOPS1. SCOPE

This specification covers the quality of materials for metal waterstops.

2. MATERIALS

Metal waterstops shall be made of copper, wrought iron or galvanized steel as specified. Waterstops that require forming of the metal involving sharp bends shall be made of copper which shall be soft enough to stand being bent cold through 180 degrees at an inside radius equal to its thickness without cracking.

3. QUALITY

Metal for waterstops shall conform to the requirements of the applicable ASTM standard specifications below:

Copper - ASTM Specification B 152

Wrought iron - ASTM Specification A 162

Zinc-coated (Galvanized) wrought iron - ASTM Specification A 163

Zinc-coated (Galvanized) steel - ASTM Specification A 526

(538-1)

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MATERIAL SPECIFICATION539. STEEL REINFORCEMENT (FOR CONCRETE)1. SCOPE

This specification covers the quality of steel reinforcement for reinforced concrete.

2. QUALITY

All reinforcement shall be free from rust, oil, grease, paint or other deleterious matter.

Steel bars for concrete reinforcement requiring bends shall be deformed billet-steel bars conforming to ASTM Specification A 615, Grade 40.

Straight steel bars shall be deformed bars conforming to one of the following specifications:

Deformed Billet-Steel Bars for Concrete Reinforcement  
(Grade 40 or Grade 60) - ASTM Designation A 615.

Rail-Steel Deformed Bars for Concrete Reinforcement  
(Grade 50 or Grade 60) - ASTM Designation A 616.

Axle-Steel Deformed Bars for Concrete Reinforcement  
(Grade 40 or Grade 60) - ASTM Designation A 617.

Fabricated steel bar mats shall conform to the requirements of ASTM Specification A 184.

Welded steel wire fabric reinforcement shall conform to the requirements of ASTM Specification A 185.

Welded deformed steel wire fabric for concrete reinforcement shall conform to the requirements of ASTM Specification A 497.

Cold-drawn steel wire reinforcement shall conform to the requirements of ASTM Specification A 82.

Deformed steel wire for concrete reinforcement shall conform to the requirements of ASTM Specification A 496.

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3. DIMENSIONS OF WELDED WIRE FABRIC

Gages, spacing and arrangement of wires in welded steel wire fabric shall be as defined in ACI Standard 315 of the American Concrete Institute for the specified style designations.

4. STORAGE

Steel reinforcement stored at the site of the work shall be stored above the ground surface on platforms, skids or other supports and shall be protected from mechanical injury and corrosion.

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MATERIAL SPECIFICATION541. REINFORCED CONCRETE PRESSURE PIPE1. SCOPE

This specification covers the quality of reinforced concrete pressure pipe and fittings.

2. DESIGN AND FABRICATION

The pipe and fittings shall be designed to withstand the specified external load and internal pressure. The pipe, the materials used in its manufacture, and the methods of fabrication shall conform to the requirements of the following specifications applicable to the specified type of pipe.

a. Steel Cylinder Type, Prestressed: AWWA Standard C301 for Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids.

b. Steel Cylinder Type, Not Prestressed: AWWA Standard C300, except that Section 2.6, Steel for Cylinders, paragraph 2.6.1 shall be:

2.6.1 Steel sheets for cylinders may be in coils or cut lengths, and shall meet the requirements of (1) the "Specification for Hot-Rolled Carbon Steel Sheets and Strip, Commercial Quality" (ASTM Designation A 569), except that the maximum carbon content may be 0.25 percent and the minimum yield point shall be 27,000 psi or (2) the "Specification for Hot-Rolled Carbon Steel Sheets and Strip, Structural Quality," Grade B or C (ASTM Designation A 570).

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- c. Noncylinder Type, Not Prestressed: AWWA Standard C302;
- d. Low Head Pressure Pipe: ASTM Specifications C 361.

Sections 1.6 and 1.7 of AWWA Standards C300, C301 and C302 shall not apply.

### 3. STEEL REINFORCEMENT

The steel reinforcements shall conform to the requirements of the specifications cited in Section 2 for the specified type of pipe, except that elliptical reinforcing cages or other reinforcements that require special orientation of the pipe during placement will not be allowed.

### 4. JOINTS

The pipe joints shall conform to the requirements of the applicable specification for the pipe. They shall be bell-and-spigot type or double-spigot-and-sleeve type and shall have a positive groove in the spigot to contain the rubber gasket. The size and shape of the groove shall be such that it will prevent displacement of the gasket by either internal or external water pressure when the joint is in any position within the required range of movement capability. Joint sleeves, also referred to as "collars" or "coupling bands," shall conform to the requirements for bell rings in the applicable pipe specification.

The joints shall be constructed so as to permit relative movement of the adjoining pipe sections with no reduction of watertightness. The joint length and the limiting angle defining the required capability of relative movement at each joint shall be no less than specified.

Joint length refers to the permissible axial movement in the joint, and is defined as the maximum distance through which the spigot can move, relative to the bell or sleeve, from the fully engaged to the fully extended condition of the joint when the adjoining pipe sections are in parallel, concentric alignment. The joint is considered to be fully engaged when the spigot is inserted as far as it will go into the bell or sleeve, and fully extended when it is inserted the least amount that will insure full confinement of the gasket and complete watertightness. Joint length specified for double-spigot joints refers to the permissible movement in each of the spigot-to-sleeve connections, not the sum of the two.

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The limiting angle of the joint is defined as the maximum deflection angle between adjoining pipe sections the joint will permit before the outer surface of the spigot comes into direct contact with inside of the mating bell or sleeve. If both spigot-to-sleeve connections of a double-spigot joint permit angular movement, the limiting angle of the joint is the sum of the two deflection angles permitted by the two connections.

## 5. GASKETS

The pipe joint gaskets shall conform to the requirements of the specifications cited in Section 2 of this specification. They shall be endless rubber gaskets having circular cross section. The cross-sectional diameter of the gaskets shall conform to the pipe manufacturer's recommendation for the type and size of pipe furnished.

## 6. MARKING

All pipe sections and special fittings shall be marked by the manufacturer with the manufacturer's name or trademark, the date of manufacture, the nominal size, design head, design external load and the structure site for which it was designed and manufactured.

## 7. INSPECTION, TESTING AND CERTIFICATION

The pipe shall be inspected by methods prescribed in the specifications cited herein, except that external crushing strength tests required as a basis for certification shall be performed by the three-edge bearing method described in ASTM Methods C 497.

The three-edge bearing load shall be defined as:

- a. For pipe conforming to ASTM Specifications C 361, AWWA Standard C300 for AWWA Standard C302, the load required to produce a 0.01-inch crack one foot long; or,
- b. For pipe conforming to AWWA Standard C301, the load required to produce a 0.001-inch crack one foot long.

The material certification will include:

- a. The pipe manufacturer's certified statement of the design strength of the pipe, consisting of:
  - (1) For types of pipe for which design curve have been approved by the Soil Conservation Service,
    - (a) a copy of the appropriate design curve marked

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to show the resultant concrete core stress and corresponding three-edge bearing load of the pipe furnished; and (b) a specification sheet for the pipe furnished showing all data and dimensions needed to compute the resultant concrete core stress; or

- (2) Results of typical external crushing strength tests performed on pipe of equivalent size and design and composed of equivalent materials, or
  - (3) Results of external crushing strength tests performed on a specimen (at least two feet in length) of pipe identical in design and construction to the pipe furnished.
- b. The pipe manufacturer's certified statement of results of the hydrostatic tests required by the reference specification appropriate to the type of pipe furnished.
  - c. The pipe manufacturer's certified statement of current typical test reports on steel and steel wire reinforcing and compression tests of the concrete used in the manufacture of the pipe.
  - d. Such drawings and descriptions of the pipe joint as may be necessary to show that the joint conforms to the specified requirements.

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MATERIAL SPECIFICATION542. CONCRETE CULVERT PIPE1. SCOPE

This specification covers the quality of nonreinforced and reinforced concrete culvert pipe.

2. NONREINFORCED PIPE

Nonreinforced concrete culvert pipe shall conform to the requirements of ASTM Specifications C 14 for the class of pipe specified.

3. REINFORCED PIPE

- a. Round pipe. Round reinforced concrete culvert pipe shall conform to the requirements of ASTM Specifications C 76 for the class of pipe specified.
- b. Arch pipe. Reinforced concrete arch culvert pipe shall conform to the requirements of ASTM Specifications C 506 for the class of pipe specified.
- c. Elliptical pipe. Reinforced concrete elliptical culvert pipe shall conform to the requirements of ASTM Specifications C 507 for the class of pipe specified.

4. RUBBER GASKET JOINTS

When rubber gasket joints are specified, the joints and gaskets shall conform to the requirements of ASTM Specifications C 443.



MATERIAL SPECIFICATION542. NONREINFORCED CONCRETE IRRIGATION PIPE,  
DRAINAGE PIPE AND DRAIN TILE1. SCOPE

This specification covers the quality of nonreinforced concrete irrigation pipe, drainage pipe, and drain tile.

2. IRRIGATION PIPE

Unless rubber gasket joints are specified, nonreinforced concrete irrigation pipe shall conform to the requirements of ASTM Specifications C 118 for Standard Concrete Irrigation Pipe.

3. IRRIGATION PIPE WITH RUBBER GASKET JOINTS

Nonreinforced concrete irrigation pipe with rubber gasket joints shall conform to the requirements of ASTM Specification C 505.

4. DRAINAGE PIPE

Nonreinforced concrete drainage pipe shall conform to the requirements of ASTM Specifications C 118 for the class of pipe specified.

5. PERFORATED PIPE

Perforated nonreinforced concrete pipe shall conform to the requirements of ASTM Specifications C 444 for the class of pipe specified.

6. DRAIN TILE

Concrete drain tile shall conform to the requirements of ASTM Specifications C 412 for the class of tile specified.

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MATERIAL SPECIFICATION544. CLAY PIPE AND CLAY DRAIN TILE1. SCOPE

This specification covers the quality of clay pipe and clay drain tile.

2. PIPE

Standard strength clay pipe shall conform to the requirements of ASTM Specifications C 13. Extra strength clay pipe shall conform to the requirements of ASTM Specifications C 200.

3. PERFORATED PIPE

Perforated clay pipe shall conform to the requirements of ASTM Specifications C 211 for the specified class of pipe.

4. DRAIN TILE

Clay drain tile shall conform to the requirements of ASTM Specifications C 4 for the specified class of tile. Perforated clay drain tile shall conform to the requirements of ASTM Specifications C 498 for the specified class.

5. COMPRESSION JOINT MATERIALS

Compression joints using materials having resilient properties shall conform to the requirements of ASTM Specification C 425.

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MATERIAL SPECIFICATION545. ASBESTOS-CEMENT PIPE1. SCOPE

This specification covers the quality of asbestos-cement pipe and fittings.

2. PRESSURE PIPE

Pressure pipe and couplings shall conform to the requirements of ASTM Specification C 296 for the specified class and type of pipe. Type I or Type II pipe shall be furnished unless otherwise specified.

Fittings other than couplings shall: (1) be cast iron or ductile iron pressure fittings compatible with the type of pipe furnished, (2) be of the all-bell, rubber-ring-connecting type with gasket retainer grooves cast or machined in the inner surfaces of the bells, and (3) otherwise conform to the requirements of AWWA Standard C110 (American National Standard A21.10). Gaskets shall conform to the requirements of ASTM Specification D 1869.

When perforated pressure pipe is specified, the number, size, location and spacing of perforations shall conform to the requirements of ASTM Specification C 508.

3. IRRIGATION PIPE

Irrigation pipe and couplings shall conform to the requirements of ASTM Specification C 296, except that lower strength will be allowed, as follows: The rated working pressure shall be not less than 75 pounds per square inch, the hydrostatic proof pressure shall be not less than 225 pounds per square inch, and the flexural proof loads and minimum crushing strengths shall be as tabulated below. Pipe and asbestos-cement fittings shall meet the chemical requirements for Type I or Type II pipe unless otherwise specified.

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<u>Applied Flexural Proof Loads</u>		<u>Minimum Crushing Loads</u>	
<u>Nominal Size inches</u>	<u>Total Applied Load, lb.</u>	<u>Nominal Size inches</u>	<u>Crushing Strength per Lin. Ft., lb.</u>
4	1000	4	1900
6	2000	6	1400
8	3700	8	1650
		10	1900
		12	2200
		14	2600
		16	2750
		18	2900
		20	3100
		24	3500
		30	4100
		36	5000

#### 4. NONPRESSURE PIPE

Nonpressure pipe and couplings shall conform to the requirements of ASTM Specification C 428 for the specified class and type of pipe. Type I or Type II pipe shall be furnished unless otherwise specified.

Fittings other than couplings shall meet the same physical and chemical requirements as the pipe and couplings.

When perforated nonpressure pipe is specified, the number, size, location and spacing of perforations shall conform to the requirements of ASTM Specification C 508.

#### 5. PERFORATED UNDERDRAIN PIPE

Perforated underdrain pipe, couplings and fittings shall conform to the requirements of ASTM Specification C 508, except that flexible couplings recommended by the pipe manufacturer will be allowed unless otherwise specified.

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MATERIAL SPECIFICATION546. BITUMINIZED FIBER PIPE1. SCOPE

This specification covers the quality of bituminized fiber pipe and fittings.

2. PIPE

Bituminized fiber pipe and fittings shall conform to the requirements of ASTM Specifications D 1861 or D 1862.

3. PERFORATED PIPE

Perforated bituminized fiber pipe and fittings for drainage shall conform to the requirements of ASTM Specification D 2311, D 2417, or D 2418.

Perforated bituminized fiber pipe and fittings for septic tank disposal fields shall conform to ASTM Specification D 2312 or D 2313.

(546-1)



MATERIAL SPECIFICATION551. ZINC-COATED IRON OR STEEL CORRUGATED PIPE1. SCOPE

This specification covers the quality of zinc-coated iron or steel corrugated pipe and fittings.

2. PIPE

Zinc-coated iron or steel corrugated pipe and fittings shall conform to the requirements of Federal Specification WW-P-405 for the specified classes and shapes of pipe, and to the following additional requirements:

- a. Unless otherwise specified, circumferential shop riveted seams shall have a maximum rivet spacing of 6 inches, except that 6 rivets will be sufficient for 12-inch diameter pipe;
- b. When close riveted pipe is specified: (1) the pipe shall be fabricated so that the rivet spacing in the circumferential seams shall not exceed 3 inches, except that 12 rivets will be sufficient to secure the circumferential seams in 12-inch pipe, and (2) in those portions of the longitudinal seams that will be covered by the coupling bands the rivets shall have finished flat heads or the rivets and holes shall be omitted and the seams shall be connected by welding to provide a minimum of obstruction to the seating of the coupling bands.
- c. Double riveting or double spot welding of pipe less than 42 inches in diameter may be required. When double riveting or double spot welding is specified, the riveting or welding shall be done in the manner specified for pipe 42 inches or greater in diameter.

3. COATINGS

Coatings shall conform to the requirements of Federal Specification WW-P-405 for the specified types of coatings.

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MATERIAL SPECIFICATION552. ALUMINUM CORRUGATED PIPE1. SCOPE

This specification covers the quality of aluminum corrugated pipe and fittings.

2. PIPE

Aluminum corrugated pipe and fittings shall conform to the requirements of Federal Specification WW-P-402 for the specified classes and shapes of pipe, and to the following additional requirements:

- a. When close riveted pipe is specified: (1) the pipe shall be fabricated so that the rivet spacing in the circumferential seams shall not exceed 3 inches, except that 12 rivets will be sufficient to secure the circumferential seams in 12-inch pipe; and (2) in those portions of the longitudinal seams that will be covered by the coupling bands the rivets shall have finished flat heads or the rivets and holes shall be omitted and the seams shall be connected by welding to provide a minimum of obstruction to the seating of the coupling bands.
- b. Double riveting of pipe less than 42 inches in diameter or double spot welding of pipe less than 30 inches in diameter may be required. When double riveting or double spot welding is specified, the riveting or welding shall be done in the manner specified for pipe of greater diameter.

3. COATINGS

Coatings shall conform to the requirements of Federal Specification WW-P-402 for the specified types of coatings.

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MATERIAL SPECIFICATION553. STEEL PIPE AND FITTINGS1. SCOPE

This specification covers the quality of steel pipe and fittings.

2. PIPE

Steel pipe shall conform to the requirements of the applicable specifications listed below for the kind of pipe and the type, weight, grade, and finish specified:

<u>Kinds of Pipe</u>	<u>ASTM Specifications</u>
Welded and seamless steel pipe (Standard Pipe)	A 53 or A 120
Electric-resistance-welded pipe (30-inch and under)	A 135
Arc-welded pipe (4-inch and over)	A 139
Arc-welded steel plate pipe (16-inch and over)	A 134
	<u>AWWA Standard</u>
Fabricated electrically welded steel water pipe	C201
Mill-type steel water pipe	C202

3. FITTINGS

Fittings shall conform to the requirements of Federal Specification WW-P-521 for the types and kinds specified.

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MATERIAL SPECIFICATION554. WROUGHT IRON PIPE AND FITTINGS1. SCOPE

This specification covers the quality of wrought iron pipe and fittings for use with wrought iron pipe.

2. PIPE

Wrought iron pipe shall conform to the requirements of the applicable ASTM specifications listed below for the kind of pipe and the weight and finish specified:

<u>Kinds of Pipe</u>	<u>ASTM Specifications</u>
Welded wrought iron pipe	A 72
Arc-welded wrought iron plate pipe	A 419

3. FITTINGS

Fittings shall conform to the requirements of Federal Specification WW-P-521 for the types and kinds specified.

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MATERIAL SPECIFICATION571. SLIDE GATES (SLUICE GATES), METAL, LIGHT DUTY1. SCOPE

This specification covers the quality of light duty, metal slide gates (sluice gates) for water control.

2. CLASS AND TYPE OF GATE

The class of gate will be expressed as a numerical symbol composed of the seating head and unseating head which the gate must be built to withstand. The two numbers will be separated by a hyphen with the seating head listed first. For this purpose the heads shall be expressed in terms of feet of water.

The gates shall be of the specified types as defined below:

Type MLS-1 gates shall be cast iron with cast iron seat facings.

Type MLS-2 gates shall be fabricated metal gates.

3. QUALITY OF MATERIALS

Materials in slide gates and appurtenances shall conform to the requirements of the applicable specifications listed below for the alloy, grade, type, or class of material and the condition and finish appropriate to the structural and operational requirements.

<u>Material</u>	<u>Specification</u> (ASTM)
Cast iron	A 48, Class 30, or A 126, Class B
Structural steel shapes, plates, and bars	A 36
Carbon steel bars	A 108 or A 575
Carbon steel sheets	A 569

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<u>Material</u>	<u>Specification</u> (ASTM)
Carbon steel strip	A 569
Zinc-coated carbon steel sheets	A 526
Cast bronze	B 147

Galvanizing (zinc coating) shall conform to the requirements of Material Specification 582.

#### 4. CAST IRON GATES

The frame shall be cast iron and of the specified type. The front face shall be machined to receive the gate guides.

The gate slide shall be cast iron and shall be built to withstand the seating and unseating heads expressed by the gate class designation, as defined in Section 2 of this specification.

Grooves shall be cast on the vertical sides of the slide to match the guide angles.

The gate guides shall be galvanized structural steel and shall be built to withstand the total thrust of the gate slide due to water pressure and wedge action.

Wedges and wedge seats shall have smooth bearing surfaces. Wedges may be cast as integral parts of the slide. Removable wedges and wedge seats shall be fastened to the slide, frame or guides by means of suitable studs, screws, or bolts and shall be firmly locked in place after adjustment. Each interacting set of wedge and wedge seat shall be adjustable as needed to insure accurate and effective contact. Adjusting bolts or screws shall be bronze or galvanized steel.

Seat facings shall be machined to a smooth finish to insure proper watertight contact.

#### 5. FABRICATED METAL GATES

Fabricated metal gates shall be built to withstand the seating head expressed by the gate class designation. Unless otherwise specified, the gates shall be galvanized steel with flat-back frames.

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6. YOKE

When a self-contained gate is specified, the yoke shall be galvanized structural steel and of such design as to capably withstand the loads resulting from operation of the gate.

7. GATE STEM AND LIFT (OR HOIST)

The gate stem and lift (or hoist) shall be of the specified type, size and capacity, and shall be capable of moving the gate slide under normal conditions, after it is unseated from its wedging device, with a pull on the handwheel or crank of not more than 25 pounds with the specified seating or unseating head of water against the gate.

Unless otherwise specified, the stem shall be carbon steel and shall be furnished in sections as necessary to permit reasonable ease in installation. Couplings shall be bolted, pinned or keyed to the stem. The stem shall be furnished with rolled or machine-cut right-hand 29° Acme threads of sufficient length to completely open the gate. The threads shall be smooth and of uniform lead and cross section, such that the nut can travel the full length without binding or excessive friction.

The lift shall be compatible with the type of stem furnished. Unless otherwise specified, the lift nut shall be cast bronze and shall be fitted with ball or roller thrust bearings designed to withstand the normal thrust developed during opening and closing of the gate at the maximum operating heads. All gears, sprockets and pinions shall be machine-cut, with ratios and strength adequate to withstand operating loads. Sufficient grease fittings shall be provided to allow lubrication of all moving parts. An arrow and the word "open" shall be cast on the rim of the handwheel or on the lift housing to indicate the direction of opening.

Provision shall be made to prevent stem rotation at the connection with the gate slide.

Stop collars shall be provided to prevent over-travel in opening and closing the gate.

8. STEM GUIDES

Unless otherwise specified, stem guides shall be cast iron and adjustable in two directions.

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9. FASTENERS

Unless otherwise specified, all anchor bolts and other fasteners shall be galvanized steel or bronze.

10. INSTALLATION INSTRUCTIONS

The Contractor shall supply the manufacturer's complete installation data, instructions for adjustments and drawings or templates showing the location of anchor bolts for each gate.

11. PAINTING

When specified, gates and accessories shall be painted by the designated systems.

12. CERTIFICATION

The material certification shall include the name of the manufacturer, the manufacturer's model number (for standard catalog items) or the seating and unseating heads for which the gate is designed together with such drawings and specifications as may be necessary to show that the gate conforms to the requirements of this specification.



MATERIAL SPECIFICATION572. SLIDE GATES (SLUICE GATES), METAL, MODERATE DUTY1. SCOPE

This specification covers the quality of moderate duty, metal slide gates (sluice gates) for water control.

2. CLASS AND TYPE OF GATE

The class of gate will be expressed as a numerical symbol composed of the seating head and unseating head which the gate must be built to withstand. The two numbers will be separated by a hyphen with the seating head listed first. For this purpose the heads shall be expressed in terms of feet of water.

The gates shall be of the specified types as defined below:

Type MMS-1 gates shall be cast iron with bronze seat facings, cast iron or galvanized structural steel guides, and galvanized steel, bronze, or stainless steel fasteners.

Type MMS-2 gates shall be cast iron with bronze seat facings, cast iron or stainless steel guides, and bronze or stainless steel fasteners. Guides and fasteners shall be stainless steel when so specified.

3. QUALITY OF MATERIALS

Materials in slide gates and appurtenances shall conform to the requirements of the applicable specifications listed below for the alloy, grade, type, or class of material and the condition and finish appropriate to the structural and operational requirements:

<u>Material</u>	<u>Specification</u> (ASTM)
Cast iron	A 48, Class 30, or A 126, Class B
Structural steel shapes, plates, and bars	A 36
Carbon steel bars	A 108 or A 575
Stainless steel	A 276, Type 302 or 304
Naval bronze	B 21

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MaterialSpecification

(ASTM)

Cast bronze

B 147

Rubber for gaskets and seals

D 2000, AA805 material

Galvanizing (zinc coating) shall conform to the requirements of Material Specification 582.

4. FRAME (OR SEAT)

The frame shall be cast iron and of the specified type. The front face shall be machined to receive the gate guides and the rear face shall be machined as required to match the specified attaching means.

5. GATE SLIDE

The gate slide shall be cast iron, rectangular in shape and shall have horizontal and vertical stiffening ribs of sufficient section to withstand the seating and unseating heads expressed by the gate class designation, as defined in Section 2 of this specification.

Tongues or grooves shall be cast or machined on the vertical sides of the slide along its entire height to match the guide grooves or angles.

A nut pocket with reinforcing ribs shall be integrally cast on the vertical centerline and above the horizontal centerline of the slide. The pocket shall be of a shape adequate to receive a flat-backed thrust nut or stem block and shall be built to withstand the opening and closing thrust of the stem.

6. GATE GUIDES

The gate guides shall be built to withstand the total thrust of the gate slide due to water pressure and wedge action.

Grooves shall be machined in cast iron guides to receive the tongue on the gate slide throughout the entire length of the guide.

The guides shall be of such length as to retain at least one-half the height of the gate slide when the gate is fully opened.

7. WEDGES AND WEDGE SEATS (OR BLOCKS)

Pads for supporting wedges, wedge seats and wedge loops (or stirrups) shall be cast as integral parts of the slide, frame or guides.

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Wedges and wedge seats shall have smooth bearing surfaces. Wedges may be cast as integral parts of the slide. Removable wedges and wedge seats shall be fastened to the slide, frame or guides by means of suitable studs, screws, or bolts and shall be firmly locked in place after adjustment. Each interacting set of wedge and wedge seat shall be adjustable as needed to insure accurate and effective contact.

8. SEAT FACINGS

Seat facings shall be machined to a smooth finish to insure proper watertight contact. Bronze facings shall be securely attached by welding or by another approved method.

9. YOKE

When a self-contained gate is specified, the yoke shall be galvanized structural steel or cast iron and of such design as to capably withstand the loads resulting from operation of the gate. Cast iron yokes shall be provided with machined pads for connecting to the ends of the gate guides and to receive the stem thrust cap or handwheel lift.

10. GATE STEM AND LIFT (OR HOIST)

The gate stem and lift (or hoist) shall be of the specified type, size and capacity and, if hand operated, shall be capable of moving the gate slide under normal conditions, after it is unseated from its wedging device, with a pull on the handwheel or crank of not more than 25 pounds with the specified seating or unseating head of water against the gate.

Unless otherwise specified, the stem shall be carbon steel and shall be furnished in sections as necessary to permit reasonable ease in installation. Couplings shall be bolted, pinned or keyed to the stem. The stem shall be furnished with rolled or machine-cut right-hand 29° Acme threads of sufficient length to completely open the gate. The threads shall be smooth and of uniform lead and cross section, such that the nut can travel the full length without binding or excessive friction. The stem shall be threaded for connection to the stem block or thrust nut on the gate slide.

The lift shall be compatible with the type of stem furnished. Unless otherwise specified, the lift nut shall be cast bronze and shall be fitted with ball or roller thrust bearings designed to withstand the normal thrust developed during opening and closing

of the gate at the maximum operating heads. All gears, sprockets and pinions shall be machine-cut, with ratios and strength adequate to withstand operating loads. Sufficient grease fittings shall be provided to allow lubrication of all moving parts. An arrow and the word "open" shall be cast on the rim of the headwheel or on the lift housing to indicate the direction of opening. Unless otherwise specified, the lift for a non-rising-stem gate shall be provided with an indicator capable of showing both when the gate is fully open and when it is fully closed.

Provision shall be made to prevent stem rotation within the thrust nut at the connection with the gate slide.

Stop collars shall be provided on rising stems to prevent over-travel in opening and closing the gate.

#### 11. STEM GUIDES

Unless otherwise specified, stem guides shall be cast iron with bronze bushed collars and adjustable in two directions.

#### 12. WALL THIMBLE

When a wall thimble is specified it shall be cast iron and of the section, type and depth specified. The front flange shall be machined to match the gate frame and drilled and tapped to accurately receive the gate attachment studs.

Gaskets or mastic to be installed between the thimble and the gate frame shall conform to the recommendation of the gate manufacturer and shall be furnished with the thimble.

#### 13. FASTENERS

All anchor bolts and other fasteners shall be galvanized or stainless steel or bronze, according to the type of gate specified as defined in Section 2 of this specification.

#### 14. INSTALLATION INSTRUCTIONS

The Contractor shall supply the manufacturer's complete installation data, instructions for adjustments and drawings or templates showing the location of anchor bolts for each gate.

#### 15. PAINTING

When specified, gates and accessories shall be painted by the designated systems.



16. CERTIFICATION

The material certification shall include the name of the manufacturer, and manufacturer's model number (for standard catalog items) or the seating and unseating heads for which the gate is designed together with such drawings and specifications as may be necessary to show that the gate conforms to the requirements of this specification.

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MATERIAL SPECIFICATION573. SLIDE GATES (SLUICE GATES), METAL, HEAVY DUTY1. SCOPE

This specification covers the quality of heavy duty, metal slide gates (sluice gates) for water control.

2. CLASS AND TYPE OF GATE

The class of gate will be expressed as a numerical symbol composed of the seating head and unseating head which the gate must be built to withstand. The two numbers will be separated by a hyphen with the seating head listed first. For this purpose the heads shall be expressed in terms of feet of water.

Gates shall be of the specified types as defined below:

Type MHS-1 gates shall have gray cast iron slides, frames, guides and yokes and shall be fitted with: (1) naval bronze seat facings, (2) manganese bronze wedges and stem blocks or thrust nuts, (3) naval bronze wedge seat facings or manganese bronze wedge blocks, (4) naval bronze or stainless steel fasteners, and (5) cold rolled steel stems, except that stems shall be stainless steel where so specified.

Type MHS-2 gates shall have gray cast iron slides, frame, guides, and yokes and shall be fitted with: (1) stainless steel seat facings, wedges, wedge seat facings, stems and fasteners, and (2) austenitic cast iron stem blocks or thrust nuts.

Type MHS-3 gates shall have austenitic gray cast iron slides, frames, guides and yokes and shall be fitted with: (1) nickel-copper alloy seat facings, wedges, wedge seat facings, stems and fasteners, and (2) austenitic cast iron stem blocks or thrust nuts.

3. QUALITY OF MATERIALS

Materials in slide gates and appurtenances shall conform to the requirements of the applicable specifications listed below for the alloy, grade, type, or class of material and the condition and finish appropriate to the structural and operational requirements:

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<u>Material</u>	<u>Specifications</u> (ASTM, except as noted)
Gray cast iron	A 48, Class 30, or A 126, Class B
Austenitic gray cast iron	A 436
Cold rolled steel	A 108
Stainless steel	A 276, Type 302, 303 or 304
Naval bronze	B 21
Phosphor bronze	B 103 or B 139
Manganese bronze	B 147
Silicon bronze	B 98
Nickel-copper alloy plate, sheet, strip	B 127
Nickel-copper alloy rod, bar	B 164
Nickel-copper alloy castings	Federal Specification QQ-N-288
Rubber for gaskets and seals	D 2000, AA805 material

#### 4. FRAME (OR SEAT)

The frame shall be cast iron and of the specified type. The front face shall be machined to receive the gate guides and the rear face shall be machined as required to match the specified attaching means. A dovetailed groove shall be machined on the perimeter of the front face to receive the seat facing.

#### 5. GATE SLIDE

The gate slide shall be cast iron, rectangular in shape and shall have horizontal and vertical stiffening ribs of sufficient section

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to withstand the seating and unseating heads expressed by the gate class designation, as defined in Section 2 of this specification. A dovetailed groove shall be machined on the perimeter of the slide face to receive the seat facing.

Tongues shall be machined on the vertical sides of the slide along its entire height to match the guide grooves with a maximum clearance of 1/16 inch for gates smaller than 54 inches by 54 inches and 1/8 inch for larger gates.

A nut pocket with reinforcing ribs shall be integrally cast on the vertical centerline and above the horizontal centerline of the slide. The pocket shall be of a shape adequate to receive a flat-backed thrust nut or stem block and shall be built to withstand the opening and closing thrust of the stem.

#### 6. GATE GUIDES

The gate guides shall be cast iron and shall be built to withstand the total thrust of the gate slide due to water pressure and wedge action.

Grooves shall be machined to receive the tongue on the gate slide throughout the entire length of the guide.

The guides shall be of such length as to retain at least one-half the height of the gate slide when the gate is fully opened.

#### 7. WEDGES AND WEDGE SEATS (OR BLOCKS)

Pads for supporting wedges, wedge seats and wedge loops (or stirrups) shall be cast as integral parts of the gate frame, slide, or guides and shall be accurately machined to receive those parts.

Wedges and wedge seats shall have machine finished bearing surfaces. They shall be fastened to the gate slide, frame or guides by means of suitable studs, screws, or bolts and shall be firmly locked in place after adjustment. Each interacting set of wedge and wedge seat shall be adjustable as needed to insure accurate and effective contact.

#### 8. SEAT FACING

Facings shall be pressed or impacted into the machined dovetailed grooves on the gate slide and frame and machined to a smooth finish to insure proper watertight contact.

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9. YOKE

When a self-contained gate is specified, the yoke shall be of such design as to capably withstand the loads resulting from operation of the gate. The yoke shall be provided with machined pads for connecting to the ends of the gate guides and to receive the stem thrust cap or handwheel lift.

10. FLUSH BOTTOM SEAL

When a flush bottom sealing gate is specified, a solid, square-corner type rubber seal shall be provided at the bottom of the gate opening. It shall be securely fastened either to the bottom of the slide or to the frame. Metal surfaces bearing on the rubber seal shall be smooth and rounded as necessary to prevent cutting of the seal during gate operation.

11. FASTENERS

All anchor bolts, assembly bolts, screws, nuts, and other fasteners shall be of ample section to withstand the forces created by operation of the gate while subjected to the specified seating and unseating heads. Quality and size of fasteners shall be as recommended by the gate manufacturer. Anchor bolts shall be furnished with two nuts to facilitate installation.

12. GATE STEM AND LIFT (OR HOIST)

The gate stem and lift (or hoist) shall be of the specified type, size and capacity and, if hand operated, shall be capable of moving the gate slide under normal conditions, after it is unseated from its wedging device, with a pull on the handwheel or crank of not more than 25 pounds with the specified seating or unseating head of water against the gate.

The stem shall be furnished in sections as necessary to permit reasonable ease in installation. Couplings shall be bolted, pinned or keyed to the stem. The stem shall be furnished with rolled or machine-cut right-hand 29° Acme threads of sufficient length to completely open the gate. The threads shall be smooth and of uniform lead and cross section, such that the nut can travel the full length without binding or excessive friction. The stem shall be threaded for connection to the stem block or thrust nut on the gate slide.

The lift shall be compatible with the type of stem furnished. Unless otherwise specified, the lift nut shall be cast manganese bronze and shall be fitted with ball or roller thrust bearings designed to withstand the normal thrust developed during opening

and closing of the gate at the maximum operating heads. All gears, sprockets and pinions shall be machine-cut, with ratios and strength adequate to withstand operating loads. Sufficient grease fittings shall be provided to allow lubrication of all moving parts. An arrow and the word "open" shall be cast on the rim of the hand-wheel or on the lift housing to indicate the direction of opening. Unless otherwise specified, the lift for a non-rising-stem gate shall be provided with an indicator capable of showing both when the gate is fully open and when it is fully closed.

Provision shall be made to prevent stem rotation within stem block or thrust nut at the connection with the gate slide.

Stop collars shall be provided on rising stems to prevent over-travel in opening and closing the gate.

#### 13. STEM GUIDES

Unless otherwise specified, stem guides shall be cast iron with bronze bushed collars and fully adjustable in two directions.

#### 14. WALL THIMBLE

When a wall thimble is specified, it shall be of the same cast iron used in the gate frame and of the section, type, and depth specified. The front flange shall be machined to match the gate frame and drilled and tapped to accurately receive the gate attachment studs.

Gaskets or mastic to be installed between the thimble and the gate frame shall conform to the recommendation of the gate manufacturer and shall be furnished with the thimble.

#### 15. INSTALLATION INSTRUCTIONS

The Contractor shall supply the manufacturer's complete installation data, instructions for adjustments and drawings or templates showing the location of anchor bolts for each gate.

#### 16. PAINTING

When specified, gates and accessories shall be painted by the designated systems.

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17. CERTIFICATION

The material certification shall include the name of the manufacturer, the manufacturer's model number (for standard catalog items) or the seating and unseating heads for which the gate is designed together with such drawings and specifications as may be necessary to show that the gate conforms to the requirements of this specification.

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MATERIAL SPECIFICATION574. FLAP GATES, METAL, LIGHT DUTY1. SCOPE

This specification covers the quality of light duty, metal flap gates for water control.

2. CLASS AND TYPE OF GATE

The class of gate will be expressed as the numerical value of the seating head which the gate must be built to withstand. For this purpose, the head shall be expressed in terms of feet of water.

Gates shall be of the specified type as defined below:

Type MLF-1 gates shall be cast iron or cast steel and shall be fitted with unbushed linkage systems and galvanized steel fasteners, or with bronze bushed linkage systems and bronze or stainless steel fasteners.

3. QUALITY OF MATERIALS

Materials in flap gates and appurtenances shall conform to the requirements of the applicable specifications listed below for the alloy, grade, type, or class of material and condition and finish appropriate to the structural and operational requirements:

<u>Material</u>	<u>Specification</u> (ASTM)
Cast iron	A 48, Class 30 or A 126, Class B
Cast steel	A 27 or A 148
Structural steel shapes, plates, and bars	A 36
Carbon steel bars	A 108 or A 575
Carbon steel sheets	A 569
Carbon steel strip	A 569

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4. FRAME

The frame shall be cast iron or cast steel and of the specified type.

5. FLAP

The flap shall be cast iron or cast steel and shall be built to withstand the seating head expressed by the gate class designation, as defined in Section 2 of this specification.

6. LINKAGE SYSTEM

The linkage system by which the flap is mounted onto the frame shall be double pivoted type for gates over 8 inches in diameter. It shall be designed to prevent the flap from folding inside of the seat and wedging in the open position.

7. SEAT FACINGS

All facings shall be machined to a smooth finish to insure proper contact.

8. GALVANIZING

Cast steel and fabricated steel parts shall be galvanized in accordance with the requirements of Material Specification 582.

9. INSTALLATION INSTRUCTIONS

The Contractor shall supply the manufacturer's complete installation data, instructions for adjustments and drawings or templates showing the location of anchor bolts for each gate.

10. PAINTING

When specified, gates and accessories shall be painted by the designated systems.

11. CERTIFICATION

The material certification shall include the name of the manufacturer, the manufacturer's model number (for standard catalog items) or the seating head for which the gate is designed together with such drawings and specifications as may be necessary to show that the gate conforms to the requirements of this specification.

(574-2)

MATERIAL SPECIFICATION575. FLAP GATES, METAL, MODERATE DUTY1. SCOPE

This specification covers the quality of moderate duty, metal flap gates for water control.

2. CLASS AND TYPE OF GATE

The class of gate will be expressed as the numerical value of the seating head which the gate must be built to withstand. For this purpose the head shall be expressed in terms of feet of water.

Gates shall be of the specified type as defined below:

Type MMF-1 gates shall be cast iron or cast steel and shall be fitted with bronze seat facings, bronze bushed linkage systems and bronze or stainless steel fasteners.

3. QUALITY OF MATERIALS

Materials in flap gates and appurtenances shall conform to the requirements of the applicable specifications listed below for the alloy, grade, type, or class of material and the condition and finish appropriate to the structural and operational requirements:

<u>Material</u>	<u>Specifications</u> (ASTM)
Cast iron	A 48, Class 30 or A 126, Class B
Cast steel	A 27 or A 148
Structural steel shapes, plates, and bars	A 36
Carbon steel bars	A 108 or A 575
Stainless steel	A 276, Type 302 or 304
Naval bronze	B 21

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<u>Material</u>	<u>Specification</u> (ASTM)
Cast bronze	B 147
Red brass	B 43
Rubber for gaskets and seals	D 2000, AA805 material

4. FRAME

The frame shall be cast iron or cast steel and of the specified type. The rear face shall be machined as required to match the specified attaching means.

5. FLAP

The flap shall be cast iron or cast steel and shall be built to withstand the seating head expressed by the gate class designation, as defined in Section 2 of this specification.

6. LINKAGE SYSTEM

The linkage system by which the flap is mounted onto the frame shall be the double pivoted type. It shall be designed to prevent the flap from folding inside of the seat and wedging in the open position. The top pivot shall be so designed as to allow adjustment of gate alignment and sensitivity.

7. SEAT FACINGS

Seat facings shall be securely attached by welding, or other approved means, and machined to a smooth finish to insure proper contact.

8. WALL THIMBLE

When a wall thimble is specified, it shall be cast iron and of the section, type and depth specified. The front flange shall be machined to match the gate frame and drilled and tapped to accurately receive the gate attachment studs.

Gaskets or mastic to be installed between the thimble and the gate frame shall conform to the recommendation of the gate manufacturer and shall be furnished with the thimble.

9. GALVANIZING

Cast steel and fabricated steel parts shall be galvanized in accordance with the requirements of Material Specification 582.

10. INSTALLATION INSTRUCTIONS

The Contractor shall supply the manufacturer's complete installation data, instructions for adjustments and drawings or templates showing the location of anchor bolts for each gate.

11. PAINTING

When specified, gates and accessories shall be painted by the designated systems.

12. CERTIFICATION

The material certification shall include the name of the manufacturer, the manufacturer's model number (for standard catalog items) or the seating head for which the gate is designed together with such drawings and specifications as may be necessary to show that the gate conforms to the requirements of this specification.





MATERIAL SPECIFICATION576. FLAP GATES, METAL, HEAVY DUTY1. SCOPE

This specification covers the quality of heavy duty, metal flap gates for water control.

2. CLASS AND TYPE OF GATE

The class of gate will be expressed as the numerical value of the seating head which the gate must be built to withstand. For this purpose the head shall be expressed in terms of feet of water.

Gates shall be of the specified types as defined below:

Type MHF-1 gates shall have gray cast iron frames and flaps and shall be fitted with naval bronze seat facings, gray cast iron or high-strength bronze hinge arms, bronze bushings, bronze hinge pins, and bronze fasteners.

Type MHF-1R gates shall be the same as Type 1 gates except that the frame shall be fitted with a rubber seat facing instead of a metal seat facing.

Type MHF-2 gates shall have gray cast iron frames and flaps and shall be fitted with stainless steel seat facings, gray cast iron or stainless steel hinge arms, and stainless steel bushings, hinge pins, and fasteners.

Type MHF-2R gates shall be the same as Type 2 gates except that the frame shall be fitted with a rubber seat facing instead of a metal seat facing.

Type MHF-3 gates shall have austenitic gray cast iron frames, flaps and hinge arms and shall be fitted with nickel-copper alloy seat facings, bushings, hinge pins and fasteners.

Type MHF-3R gates shall be the same as Type 3 gates except that the frame shall be fitted with a rubber seat facing instead of a metal seat facing.

3. QUALITY OF MATERIALS

Materials in flap gates and appurtenances shall conform to the requirements of the applicable specifications listed below for the alloy, grade, type, or class of material and the condition and finish appropriate to the structural and operational requirements:

<u>Material</u>	<u>Specification</u> (ASTM, except as noted)
Gray cast iron	A 48, Class 30, or A 126, Class B
Austenitic gray cast iron	A 436
Carbon steel bars	A 108 or A 575
Stainless steel	A 276, Type 302, 303, or 304
Naval bronze	B 21
Phosphor bronze	B 103 or B 139
Manganese bronze	B 147
Silicon bronze	B 98
Red brass	B 43
Nickel-copper alloy plate, sheet, strip	B 127
Nickel-copper alloy rod, bar	B 164
Nickel-copper alloy castings	Federal Specification QQ-N-288
Rubber gaskets and seals	D 2000, AA805 material

4. FRAME

The frame shall be of the specified type. The rear face shall be machined as required to match the specified attaching means.

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A groove shall be machined on the perimeter of the front face to receive the seat facing.

5. FLAP

The flap shall be built to withstand the seating head expressed by the gate class designation, as defined in Section 2 of this specification.

A groove shall be machined on the perimeter of the face to receive the seat facing.

6. LINKAGE SYSTEM

The linkage system by which the flap is mounted onto the frame shall be the double pivoted type. It shall be designed to prevent the flap from folding inside of the seat and wedging in the open position. The top pivot shall be so designed as to allow adjustment of gate alignment and sensitivity.

7. SEAT FACINGS

Metal facings shall be pressed or impacted into machined dovetailed grooves on the flap and frame (or securely attached in the seat grooves by means of studs, set screws or other approved means) and machined to a smooth finish to insure proper contact. Rubber facings shall be pressed into a dovetailed groove in the frame.

8. WALL THIMBLE

When a wall thimble is specified, it shall be of the same cast iron used in the gate frame and of the section, type, and depth specified. The front flange shall be machined to match the gate frame and drilled and tapped to accurately receive the gate attachment studs.

Gaskets or mastic to be installed between the thimble and the gate frame shall conform to the recommendation of the gate manufacturer and shall be furnished with the thimble.

9. INSTALLATION INSTRUCTIONS

The Contractor shall supply the manufacturer's complete installation data, instruction for adjustments and drawings or templates showing the location of anchor bolts for each gate.

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10. PAINTING

When specified, gates and accessories shall be painted by the designated systems.

11. CERTIFICATION

The material certification shall include the name of the manufacturer, the manufacturer's model number (for standard catalog items) or the seating head for which the gate is designed together with such drawings and specifications as may be necessary to show that the gate conforms to the requirements of this specification.

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MATERIAL SPECIFICATION577. RADIAL GATES (TAINTER GATES)1. SCOPE

This specification covers the quality of radial gates for water control.

2. QUALITY OF MATERIALS

Materials in radial gates and appurtenances shall conform to the requirements of the applicable specifications listed below for the alloy, grade, type, or class of material and the condition and finish appropriate to the structural and operational requirements:

<u>Material</u>	<u>Specification</u> (ASTM)
Cast iron	A 48, Class 30 , or A 126, Class B
Cast steel	A 27 or A 148
Structural steel shapes, plates and bars	A 36
Carbon steel bars	A 108 or A 575
Stainless steel	A 276, Type 302, or 304
Zinc coated steel sheets	A 526
Naval bronze	B 21
Cast bronze	B 147

Galvanizing (zinc coating) shall conform to the requirements of Material Specification 582.

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3. GATES

Unless otherwise specified, the gates shall be fabricated from structural steel with skin plates made of smooth or corrugated iron or steel sheets. They shall conform to the dimensions shown on the drawings and shall be built to withstand the specified head. The curvature of the skin plate shall be concentric with the pivot pins or trunnions. Gates shall be supplied complete with pin bearings, pins, hoist, galvanized hoisting cable and all anchor bolts. Unless otherwise specified, the pin bearings shall be cast iron and of the embedded type.

4. HOIST

Hoists shall be of the worm-gear type and shall be equipped with hand crank or be power operated as specified on the drawings. Hoists shall be furnished complete with all lubricants, anchor bolts and other appurtenances necessary for their installation and operation.

5. RUBBER SEALS

Each gate shall be fitted with rubber seals along the side and bottom edges of the gate face. The seals shall be of the belt type or "J" type, as specified, and shall be designed to bear on the walls and bottom of the structure or on rubbing plates and sills to insure a watertight fit when the gate is closed. When specified, a rubber seal shall also be provided at the top edge of the gate.

6. INSTALLATION INSTRUCTIONS

The Contractor shall supply the manufacturer's complete installation data, instructions for adjustments and drawings or templates showing the location of anchor bolts and pin bearings for each gate.

7. PAINTING

Gates and accessories shall be galvanized or painted by the specified systems.

8. CERTIFICATION

The material certification shall include the manufacturer's name and the head for which the gate is designed together with such drawings and specifications as may be necessary to show that the gate conforms to the requirements of this specification.

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MATERIAL SPECIFICATION581. METAL1. SCOPE

This specification covers the quality of steel and aluminum alloys.

2. STRUCTURAL STEEL

Structural steel shall conform to the requirements of ASTM Specification A 36.

High-strength low-alloy structural steel shall conform to ASTM Specification A 242 or A 588.

Carbon steel plates of structural quality to be bent or formed cold shall conform to ASTM Specification A 283, Grade C.

Carbon steel sheets of structural quality shall conform to ASTM Specification A 570, Grade D or A 611, Grade D.

Carbon steel strip of structural quality shall conform to ASTM Specification A 570, Grade C.

3. COMMERCIAL OR MERCHANT QUALITY STEEL

Commercial or merchant quality steel shall conform to the requirements of the applicable ASTM specifications listed below:

<u>Product</u>	<u>ASTM Specification</u>
Carbon steel bars	A 575, Grade M 1015 to Grade M 1031
Carbon steel sheets	A 569
Carbon steel strip	A 569
Zinc-coated carbon steel sheets	A 526

4. ALUMINUM ALLOY

Aluminum alloy products shall conform to the requirements of the applicable ASTM specifications listed below. Unless otherwise specified, Alloy 6061-T6 shall be used.

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<u>Product</u>	<u>ASTM Specification</u>
Standard structural shapes	B 308
Extruded structural pipe and tube	B 429
Extruded bars, rods, shapes and tubes	B 221
Drawn seamless tubes	B 210
Rolled or cold-finished bars, rods and wire	B 211
Sheet and plate	B 209

#### 5. BOLTS

Steel bolts shall conform to the requirements of ASTM Specification A 307. If high-strength bolts are specified they shall conform to the requirements of ASTM Specification A 325.

When galvanized or zinc-coated bolts are specified, the zinc coating shall conform to the requirements of ASTM Specification A 153; except that bolts 1/2 inch or less in diameter may be coated with electrodeposited zinc or cadmium coating conforming to the requirements of ASTM Specification A 164, Type RS, or ASTM Specification A 165, Type TS, unless otherwise specified.

#### 6. RIVETS

Unless otherwise specified, steel rivets shall conform to the requirements of ASTM Specification A 502, Grade 1.

Unless otherwise specified, aluminum alloy rivets shall be Alloy 6061-T6 conforming to the requirements of ASTM Specification B 316.

#### 7. WELDING ELECTRODES

Steel welding electrodes shall conform to the requirements of American Welding Society specification AWS A5.1, "Specification for Mild Steel Covered Arc-Welding Electrodes," except that they shall be uniformly and heavily coated (not washed) and shall be of such a nature that the coating will not chip or peel while being used with the maximum amperage specified by the manufacturer.

Aluminum welding electrodes shall conform to the requirements of American Welding Society specification AWS A5.10, "Specification for Aluminum and Aluminum-Alloy Welding Rods and Bare Electrodes."

MATERIAL SPECIFICATION582. GALVANIZING1. SCOPE

This specification covers the quality of zinc coatings applied to iron and steel products.

2. QUALITY

Zinc coatings shall conform to the requirements of the following specifications.

Zinc coatings on products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strip, 1/8 inch thick and heavier shall conform to ASTM Specification A 123.

Zinc coatings on assembled steel products shall conform to the requirements of ASTM Specification A 386 and shall be applied in conformance with the Recommended Practice for Providing High Quality Zinc Coatings (Hot-Dip) on Assembled Products (ASTM Designation A 385).

Zinc coatings on iron and steel hardware shall conform to the requirements of ASTM Specification A 153 except that bolts, screws and other fasteners 1/2 inch or less in diameter may be coated with electrodeposited zinc or cadmium coating conforming to the requirements of ASTM Specification A 164, Type RS, or ASTM Specification A 165, Type TS, unless otherwise specified.

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MATERIAL SPECIFICATION583. COAL TAR-EPOXY PAINT (FORMULA C-200)1. SCOPE

This specification covers the quality of a coal tar polyamide epoxy paint suitable for use on structural steel or concrete. (Note: Coatings compounded from coal tar and epoxy resins are the subject of U.S. Patent No. 2,765,288 held by the U.S.S. Chemicals, a Division of United States Steel Corporation, Pittsburgh, Pennsylvania, 15230.)

2. COMPOSITION AND PROCESSING

- a. Composition. The paint shall be a two-component system containing the pitch, filler and catalyst in one component and the resin in another. The components shall contain the following types and proportions of ingredients:

(1) COMPONENT A

<u>Ingredient</u>	<u>% by Wt.</u>	<u>Gallons (absolute) in 38.5 lb. batch</u>
Coal Tar Pitch	35.0	1.28
Polyamide Resin	11.5	0.55
Magnesium Silicate	31.0	0.51
Xylene	18.7	1.00
Ethyl Alcohol (95%-denatured)	1.0	0.06
Gelling Agent	1.5	0.04
Catalyst	1.3	0.06
	<u>100.0</u>	<u>3.50 gallons</u>

(2) COMPONENT B

Epoxy Resin (100% nonvolatile)	9.7 pounds	1.0 gallon
-----------------------------------	------------	------------

- b. Processing. Magnesium silicate and gelling agent shall be thoroughly dispersed in Component A by means of grinding equipment capable of developing substantial shear values. Gellant shall be mixed with an equal weight of magnesium silicate and then dampened by stirring-in all of the alcohol;

(583-1)



the resultant mixture shall be added to and thoroughly dispersed into Component A. (The viscosity of Component A will be markedly influenced by the degree of dispersion of gellant and magnesium silicate.)

- c. Quality of Ingredients. Ingredient materials shall exhibit the following properties:

- (1) Coal Tar Pitch. Coal tar pitch shall have the following characteristics:

	<u>Minimum</u>	<u>Maximum</u>
B & R softening point, degree C (Method ASTM D 36)	70	75.0
Ash, percent by weight (Method ASTM D 271)		0.5
Benzene insolubles, percent by weight (Method ASTM D 367)		18.0
Volatiles, percent by weight		
Under 250 degrees C		0.0
Under 300 degrees C		5.0

- (2) The Gellant. The gellant or thixotrophy-producing additive for coal tar-epoxy paint shall be an organic derivative of magnesium montmorillonite for use in low polarity hydrocarbons. It shall be a creamy white powder having a bulking value of  $15 \pm 0.2$  lbs. per gallon and water content of 3.0% maximum (Bentone 38, National Lead Company has these properties.)

- (3) The Catalyst. The catalyst shall be 3, 4, 6 Tri-(Dimethylamino methyl) phenol. (DMP-30 Rohm and Haas Company is such a chemical.)

- (4) Epoxy Resin. Epoxy resin shall be a diepoxide condensation product of bisphenol A and epichlorohydrin with terminal epoxide group with the following properties:

	<u>Minimum</u>	<u>Maximum</u>
Nonvolatile content	99	
Epoxide equivalent	180	200

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	<u>Minimum</u>	<u>Maximum</u>
Color, Gardner		5
Viscosity, 25°C, Brookfield, Poises	100	160
Specific Gravity 25°C/25°C	1.15	1.18
(5) <u>Polyamide Resin</u> . Polyamide resin shall be a condensation product of dimerized fatty acid and polyamines with the following characteristics:		
Amine Value	330-360	
Color, Gardner	12 maximum	
Specific Gravity 25°C/25°C	0.96-0.98	
Viscosity, Poises, 75°C, Brookfield	7-9	
Nonvolatile content, percent	97	
(6) <u>Xylene</u> . Xylene shall conform to Federal Specification TT-X-916b, "Xylene (for use in organic coatings)."		
(7) <u>Ethyl Alcohol</u> . Ethyl alcohol (95% denatured) shall conform to Federal Specification O-E-760b, and Amendment 2, "Ethyl Alcohol (Ethanol); Denatured Alcohol; and Proprietary Solvent," Grade III or IV.		
(8) <u>Magnesium Silicate</u> . Magnesium silicate shall conform to Federal Specification TT-P-403, "Pigment, Magnesium Silicate, Dry," Medium Oil Absorption.		

### 3. PHYSICAL REQUIREMENTS

When tested by the methods described in Section 4:

a. Component A shall exhibit the following properties:

- |                                    |             |
|------------------------------------|-------------|
| (1) Viscosity, poises (Brookfield) | 160 maximum |
| (2) Nonvolatile residue, percent   | 78 minimum  |

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b. The mixed paint shall exhibit the following properties:

- |                                  |           |
|----------------------------------|-----------|
| (1) Sag, 12 mil wet film         | None      |
| (2) Pot life at 77° ± 3°F, hours | 4 minimum |

c. The cured film shall exhibit the following properties:

- |  |                 |
|--|-----------------|
| (1) Penetration, 200 grams, 5 seconds,<br>77°F, hundredth centimeter units | 3 maximum       |
| (2) Odor after 48 hours curing   | Pass test       |
| (3) Flexibility on ½-inch mandrel  | Pass test       |
| (4) Adhesion   | No delamination |

4. TEST METHODS

- a. Viscosity of Component A. Fill a container having a diameter and a height of not less than 3 and 3-3/4 inches respectively to a depth of not less than 3 inches with a representative sample of Component A. Set up a Model RVT or RVF-100 Brookfield Synchro-Electric Viscometer with a No. 7 spindle and with guard removed. Bring the sample to a temperature of 25°C and stir vigorously for 2 minutes with a stiff spatula. Immediately after stirring, lower the viscometer until the spindle is immersed until ½ of the "neck" mark is covered. Run the viscometer at 100 r.p.m. for 1 minute and take a reading of the position of the pointer on the dial. If the dial reading is 40 or less, the viscosity shall be considered to be 160 Poises or less. If the reading is over 40, immediately start the motor and take additional readings at 1-minute intervals. If no readings of 40 or less are obtained out of 10 readings, taken at 1-minute intervals, the viscosity of the material shall be considered to be over 160 Poises.
- b. Nonvolatile Content of Component A. Place a short length of stiff wire such as a partially-straightened paper clip into a small disposable aluminum dish of about 2 inches diameter and weigh to the nearest 0.1 milligram. As rapidly as possible, place between 2 and 3 grams of Component A into the dish and weigh immediately to the nearest 0.1 milligram. After weighing, spread the material over the bottom of the dish. Heat the dish, wire and contents in a well-ventilated

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convection-type oven maintained at  $105^{\circ} \pm 2^{\circ}\text{C}$ , for 3 hours. After the material has been in the oven for a few minutes, and periodically thereafter, stir the material. Cool in a desiccator, weigh to the nearest 0.1 milligram and calculate the percentage nonvolatile.

- c. Sag Test of Coal Tar-Epoxy Paint. Prepare approximately one pint of the material by thoroughly mixing 100 ml. of Component B into 350 ml. of Component A. Determine its viscosity immediately after mixing, using the same procedure as for Component A above but employing a No. 6 spindle. If the material produces a scale reading of more than 80, at 100 r.p.m. after 5 readings taken at 1-minute intervals, reduce the viscosity by adding xylene in small increments until a reading not greater than 80 is obtained. Press a strip of 1-inch masking tape across the full width of a solvent cleaned 3" x 6" cold-rolled steel panel. The tape should be parallel to and centered on the shorter axis of the panel. Within 30 minutes after mixing, apply the material to the panel to a wet film thickness of at least 12 mils as determined by an Interchemical wet film thickness gage. The application may be made with a doctor blade having a gap of approximately 25 mils or by brush. Immediately after applying the material, carefully remove the masking tape and stand the panel in a vertical position with the bare strip horizontal. Examine the panel after four hours. Sagging or running of the coating into the bare area shall constitute failure of the material to pass the sag test.
- d. Penetration Test on Coal Tar-Epoxy Film. Select and solvent spray-clean two 3" x 6" steel panels in accordance with Method 2011 of Federal Test Method Standard 141. Draw down, in accordance with Method 2161, a coat of the paint mixed (including any thinning) for the sag test. Allow the film to dry 18 to 24 hours in a horizontal position at  $77^{\circ} \pm 3^{\circ}\text{F}$  and at a relative humidity of not over 60%. Apply a second coat over and at right angles to the first, using freshly mixed paint prepared identically to that used for the first coat. The draw-down applicator(s) shall be such as to provide a total dry-film thickness for the two coats of  $23 \pm 3$  mils and the coats shall be of approximately equal thickness. Allow the second coat to dry in a horizontal position for 120 hours at  $77^{\circ} \pm 3^{\circ}\text{F}$ . After 72 hours of curing, and daily thereafter, clamp the panel onto the table of a penetrometer (ASTM D5) so that the needle is over an area which is within the prescribed thickness range (as measured by Method 6181) and determine

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the penetration, using a total load of 200 grams applied for 5 seconds at 77°F. The average of the 3 lowest out of 5 penetration readings, all taken within a 1 centimeter square, shall not exceed 3/100 of a centimeter after 120 hours of curing.

- e. Flexibility of Coal Tar-Epoxy Film. Sandblast 3 steel panels (similar to those used in the penetration test) at low pressure with clean, 30 to 50 mesh, non-metallic abrasive until a uniform, gray-white surface, with well developed anchor pattern, is achieved. (Note: It may be necessary to blast both sides of panel, in stages, to avoid warping.) Blow off dust with a clean air blast. Immediately after recoating of the penetration test panel, apply 10 to 12 mils (wet thickness as determined with an Interchemical gage) of the same material to the flexibility test panels in accordance with Method 2161, Federal Test Method Standard No. 141. Allow the film to cure in the horizontal position for 120 hours at  $77^{\circ} \pm 3^{\circ}\text{F}$  or for a period equal to that required to reach a penetration of 3/100 centimeter on the penetration test panel, whichever occurs first. With film side up, and in a time interval of approximately 1 second, bend each of the flexibility panels double over a 1/2-inch diameter mandrel. Cracks in any of the panels visible to the naked eye shall constitute failure except that edge cracks extending no further than 1/2 inch or small local fissures emanating from air bubbles, craters and similar imperfections shall be disregarded.
- f. Adhesion of Coal Tar-Epoxy Film. Test the adhesion of the coating on an unbroken area of the flexibility panel with a sharp knife after the panel has cured 120 hours. It shall strongly resist being removed from the metal. Also, test the intercoat adhesion of the film on a penetration panel after 120 hours curing, with a knife. Any delamination of the two coats shall constitute failure.
- g. Pot Life Test of Coal Tar-Epoxy Paint. Mix 100 ml. of Compound "B" into 350 ml. of Component "A" both of which have been brought to a temperature of  $77^{\circ} \pm 3^{\circ}\text{F}$  before mixing. Pour the material into a pint tin can, seal tightly and maintain at  $77^{\circ} \pm 3^{\circ}\text{F}$ . Examine the material in four hours from the time it was mixed. For its pot life to be considered satisfactory, the mixed material must still be in a fluid condition and when thinned with no more than 100 ml. of xylene shall be lump-free and brushable.

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- h. Odor of Dried Coal Tar-Epoxy Film. Examine the paint film or one of the flexibility panels for odor after it has been cured for 48 hours. The film shall be free of any odor except for a faint odor of xylene.

5. PACKAGING

Three and one-half gallons of Component A shall be packaged in a standard 5-gallon container with a lug-type, removable lid. Component B shall be packaged to the full mark in a one-gallon, friction-lid container. In addition to other labelling requirements, each of the 5-gallon containers shall bear instructions for properly mixing the two components immediately prior to use.

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MATERIAL SPECIFICATION584. STRUCTURAL TIMBER AND LUMBER1. SCOPE

This specification covers the quality of structural timber, lumber and plywood.

2. GRADING

Structural timber and lumber shall be graded in accordance with the grading rules, applicable to the specified species, adopted by a lumber grading or inspection bureau or agency recognized as being competent and that conform to the basic principles of ASTM Methods D 245. The material supplied according to the commercial grading rules shall be of equal or greater stress value than the specified stress-grade.

Plywood shall conform to the requirements of Product Standard PS 1-66 for the grade, species or group, and type specified.

3. QUALITY

All materials shall be sound wood free from decay. No boxed heart pieces of Douglas fir or redwood shall be used in stringers, floor beams, caps, posts, sills or other principal structural members. Boxed heart pieces are defined as timber so sawed that at any section in the length of a sawed piece the pith lies entirely inside the four faces.

4. HEARTWOOD REQUIREMENTS

All timber and lumber specified for use without preservative treatment shall contain not less than 75 percent heartwood on any diameter or on any side or edge, measured at the point where the greatest amount of sapwood occurs. This requirement shall not apply to timber and lumber for which pressure treatment with wood preservative is specified.

5. SIZES

The sizes specified are nominal sizes. Unless otherwise specified the material shall be furnished in American Standard dressed sizes.

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6. MARKING

Each piece of timber and lumber shall be legibly stamped or branded with an official grade mark. Plywood shall be legibly stamped with an official mark designating the grade, type and surface finish as described in the cited Product Standard.

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MATERIAL SPECIFICATION585. WOOD PRESERVATIVES AND TREATMENT1. SCOPE

This specification covers the quality of wood preservatives and methods of treatment of wood products.

2. TREATING PRACTICES

Treating practices and sampling, inspection and test procedures shall conform to the requirements of Federal Specification TT-W-571, "Wood Preservation: Treating Practices."

3. PRESERVATIVES

The wood shall be treated with the specified type of preservative. Wood preservatives shall conform to the requirements of the applicable specifications listed in Federal Specification TT-W-571.

4. QUALITY OF TREATED MATERIALS

Treated lumber, timber, piles, poles, or posts shall be free from heat checks, water bursts, excessive checking, results of chafing or from any other damage or defects that would impair their usefulness or durability for the purpose intended. The use of "s" irons will not be permitted. Holes bored for tests shall be filled with tight fitting treated plugs.

5. MARKING

Each treated wood item delivered to the job site shall be marked as specified in Federal Specification TT-W-571 unless otherwise specified.

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MATERIAL SPECIFICATION591. FARM FIELD FENCING MATERIALS1. SCOPE

This specification covers the quality of materials used in the construction of farm field fences.

2. WIRE GAGE

When the size of steel wire is designated by gage number, the diameter shall be as defined for U. S. Steel Wire Gage.

3. FENCING

Barbed wire, woven wire and wire netting fencing shall conform to the requirements of Federal Specification RR-F-221 for the specified types and styles of fencing. Wire shall have Class 2 zinc coating unless otherwise specified.

4. STAYS, BRACING AND TENSION WIRE

Stays shall conform to the requirements of Federal Specification RR-F-221 unless otherwise specified. Bracing and tension wires shall have a tensile strength not less than 58,000 pounds per square inch. Stays and bracing and tension wire shall be zinc-coated as specified for the fencing wire.

5. WOOD FENCE POSTS AND BRACES

Wood posts shall be of black locust, red cedar, osage orange (Bois d'Arc), redwood, pressure treated pine or other wood of equal life or strength. At least half the diameter or diagonal dimension of red cedar or redwood posts shall be in heartwood. Pressure treatment shall conform to Material Specification 585. The posts shall be sound, new, free from decay, with all limbs trimmed substantially flush with the body. They shall be substantially straight throughout their length.

Wood braces shall be of material equal to or better than construction grade Douglas fir. They shall be pressure treated in conformance with Material Specification 585.

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6. STEEL FENCE POSTS AND BRACES

Steel fence posts and braces shall conform to the requirements of Federal Specification RR-F-221. Posts with punched tabs for fastening the wires shall not be used.

7. CONCRETE FENCE POSTS

Concrete fence posts shall be manufactured to the specified requirements of size, shape, and strength.

8. PANEL GATES

Panel gates shall be the specified types, sizes, and quality and shall include the necessary fittings. The fittings shall consist of not less than two hinges and two latches or galvanized chains for fastening. Latches shall be of such design that a padlock may be used for locking. All fittings shall be equivalent to the gate manufacturer's standard.

9. WIRE GATES

Wire gates shall be the type shown on the drawings, constructed in accordance with these specifications at the locations and to the dimensions shown on the drawings. The materials shall conform to the kinds, grades, and sizes specified for new fence, and shall include the necessary fittings and stays.

10. STAPLES

Staples used to fasten fence wire to wood posts shall be 9-gage galvanized wire with a minimum length of 1½ inches for soft woods and a minimum length of one inch for close-grain hardwoods.

11. GALVANIZING

All iron and steel fencing materials, except as otherwise specified, shall be zinc coated by the hot dip process, except that clips, tie wires, bands or other fabric fasteners may be protected by electrodeposited zinc or cadmium coating. Zinc or cadmium coating shall conform to the requirements of Material Specification 582.

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